



FY 1999

Hanford Technology Deployment Accomplishments



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FY 1999 Hanford Technology Deployment Accomplishments

Accelerating cleanup tops the list of the Department of Energy's priorities at Hanford. During Fiscal Year 1999, we made organizational changes to the Richland Operations Office to provide a more streamlined focus on accomplishing cleanup work. And Congress formed the Office of River Protection to ensure safeguarding of the Columbia River.

Our approach to Hanford cleanup is focused on protecting the Columbia River Corridor, where stored spent nuclear fuel, hundreds of waste sites and contaminated groundwater plumes threaten the environment; and treating and storing waste in Hanford's Central Plateau, home to 177 aging underground waste tanks containing 54 million gallons of high-level radioactive waste. Applying innovative science and technology from national laboratories, colleges and universities, and private industry is critically important to our complex cleanup work as well as other key DOE missions.

In Fiscal Year 1999, Hanford deployed 23 new technologies in cleanup projects across the site, nearly doubling our goal of 12 deployments. Fourteen of those technologies were in projects in Hanford's Central Plateau, including nine at tank waste sites. These deployments produced valuable information to determine how effective the technologies were in the field and how they compare to existing cleanup methods. In many cases, the technology deployed presented a candidate new solution to a problem where no treatment existed previously.

Just as we look to new products to improve the efficiency of our homes and offices, the Department of Energy relies on the development and deployment of new technologies for safer, cheaper, and more cost-effective cleanup solutions. Whether we're talking about characterization, treatment, or waste disposal, we are continuing our efforts to incorporate new technologies to expedite progress.

This report contains descriptions of the benefits and features of the FY 1999 demonstrations and deployed technologies. We hope you will find this information useful in understanding the contributions that new technologies are providing to help accomplish the Hanford cleanup mission.

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A handwritten signature in dark ink, appearing to read "Keith Klein".

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INTRODUCTION

In November 1989, the Department of Energy (DOE) established the Office of Environmental Restoration and Waste Management (EM) to address cleanup issues in the DOE weapons complex, prevent further environmental contamination and institute responsible environmental management. While performing its tasks, EM found that many aspects of its large and complex mission could not be achieved using existing science and technology or without incurring unreasonable costs, risks, or schedule impacts. Consequently, efforts have been implemented to focus the resources of the Office of Science and Technology (EM-50), the National Laboratories, cleanup contractors, private industry and colleges and universities on deploying new technologies to facilitate cleanup efforts.

This document provides fact sheets for technologies deployed and demonstrated in Fiscal Year 1999 at the Hanford Site near Richland, Washington. Points-of-contact are listed on each fact sheet and further information can be found on the Hanford home page, www.hanford.gov.

On the front cover: Photos represent technology deployment and project activities for moving spent nuclear fuel from K Area (center) storage to interim dry storage in the central plateau at Hanford.



TECHNOLOGY DEPLOYMENTS

TABLE OF CONTENTS

| | |
|---|----|
| SPENT NUCLEAR FUEL PROJECT | 1 |
| Fuel Retrieval System..... | 3 |
| Consolidated Sludge Sampler..... | 5 |
| Integrated Water Treatment System (IWTS)..... | 7 |
| Enhanced Thermo-Gravimetric Analysis (TGA) Instrument | 9 |
| RIVER PROTECTION PROJECT..... | 11 |
| RTD Pit Leak Detectors..... | 13 |
| Slim-Hole Neutron and Gamma Probes..... | 15 |
| Saltwell Portable Exhauster..... | 17 |
| Enraf Annulus Leak Detector | 19 |
| New Generation Transfer Pump | 21 |
| Sidewall Sampler for Characterizing Tank Farm Vadose Zone | 23 |
| Enraf Densitometer in Tank AY-102 | 25 |
| New Generation Continuous Air Monitors..... | 27 |
| Continuous Length Leak Detector..... | 29 |
| WASTE MANAGEMENT..... | 31 |
| Automated Resource-Loaded Scheduling of Production Activities | 33 |
| FACILITY STABILIZATION PROJECT..... | 35 |
| Power Tool Estimator Used for PFP Integrated Program Management Plan..... | 37 |
| INFRASTRUCTURE | 39 |
| Field Simulator for System Testing and Start-Up (SIMCart™) | 41 |
| ENVIRONMENTAL RESTORATION..... | 43 |
| In Situ Redox Manipulation..... | 45 |
| 3-D Visual and Gamma Ray Imaging System..... | 47 |
| Quantrad Scout Gamma Spectroscopy System..... | 49 |
| Alpha Sentry Continuous Air Monitor | 51 |
| Enhanced Site Characterization System (ESCS)..... | 53 |
| Non-Intrusive Liquid Level Detection Technology | 55 |
| Hand-Held Exploranium GR-130 miniSPEC Instrument..... | 57 |

TECHNOLOGY DEPLOYMENTS

SPENT NUCLEAR FUEL PROJECT



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Fuel Retrieval System

The Challenge

Hanford's water-filled K Basins contain a large amount of uranium metallic fuel which was previously irradiated in the N Reactor. This fuel consists of approximately 100,000 fuel assemblies and is contained in stainless steel canisters. The Hanford Spent Nuclear Fuel Project has assumed the task of moving this fuel from K Basins to a new dry storage facility which is considerably farther from the Columbia River. This task includes remotely removing the fuel from its current canisters and placing it in 400 new large multi-canister overpacks (MCOs).



Left - fuel element decapping station, center – central control console, right – robotic (Konan) arm for loading fuel assemblies. Other system components not shown include canister slitting station, fuel sorting tables, underwater cameras and fuel cleaning machine.

The fuel is currently in various stages of degradation after two decades of underwater storage, resulting in radioactive sludge that is generated by the fuel. The release of this sludge during fuel movement has the potential to obscure and delay work. The canisters in K-West Basin, in particular, are sealed and therefore have the potential to trap hydrogen gas and radioactive species that are byproducts of corrosion and that are released to the basin during fuel handling. Observations made during characterization of the fuel also indicate that there is the potential for fuel assemblies to be stuck in their canisters because of corrosion-induced swelling such that standard tools will not remove the fuel.

K-West Basin is the first of the two basins to begin fuel removal. The challenge is to safely open the sealed canisters, remove the fuel, efficiently load MCOs, and deal with any effluent (particulate and gas) which may exit the old canisters during the process.

Current Approach

Prior to the installation of the Fuel Retrieval System (FRS), fuel had been moved manually using poles or small grappling tools when characterization or fuel management necessitated such movement. This requires the handling of a 50-pound weight on the end of a 20-foot pole with an obvious potential of operator fatigue and risk of injury given the large number of fuel assemblies involved. Fuel movements, on the scale contemplated now, have not been undertaken in the past. No serious attempts to clean fuel (other than some experimental brushing) had been made prior to the current campaign.

Benefits and Features

- ◆ Remote opening of fuel canisters
- ◆ Ability to extract fuel which is stuck in canisters
- ◆ Remote fuel movement with reduced risk to personnel
- ◆ Removal of sludge and adhering debris from fuel

Previous attempts to open canisters for fuel characterization did not have the ability to interface with large capacity gas or sludge mitigation systems. Installed equipment capable of emptying canisters with stuck fuel has not been available in the K-West Basin prior to FRS deployment.

New Technology

The FRS has been deployed in the K-West Basin. It consists of a decapping station, a canister slitting station, fuel sorting tables, underwater cameras, a fuel cleaning machine, and robotic manipulator arms. The decapping station must deal with two completely different lid designs utilized for K-West canisters. Lids are dislodged by injecting pressurized water through valves that are imbedded in the lids. Contaminated water, trapped loose sludge and gas are diluted and flushed from the canisters into the appropriate disposal systems. Subsequently, double-barreled canisters are placed individually in the Primary Cleaning Machine for removal of all but the most tenaciously adhering sludge and fuel coating material. This machine is capable of tumbling an entire canister of fuel while pressurized water and the rocking motion of the fuel itself help dislodge particulate. Effluent from this machine is directed to the Integrated Water Treatment System (IWTS) which deals with the sludge entrained in the wash water. Fuel is then removed from the canisters to sorting tables. If the fuel is stuck in the canister, the fuel slitting station provides the capability to cut the canister walls vertically at two opposing locations and to

force the barrel sides apart. Two robotic arms ("Konan Arms") are then used to load the fuel assemblies and pieces of various sizes into baskets, which in turn are placed in MCOs. Complete underwater camera coverage facilitates the fuel sorting, transfer and inspection processes.

The FRS is a multi-step system that provides for the efficient transfer of fuel, the capture of byproducts, and the capability to handle the multitude of different levels of damage in the fuel assemblies. This technology provides worker safety and increased productivity accelerating completion of the project.

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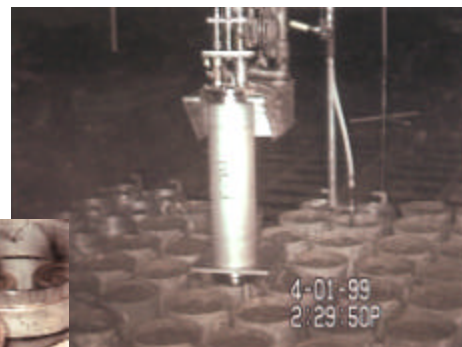
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TM-DEP-99-010



Consolidated Sludge Sampler

The Challenge

The Hanford Spent Nuclear Fuel (SNF) Project is preparing to move N Reactor fuel from the water-filled K Basins to interim dry storage. Intermingled with this uranium metal fuel is radioactive sludge on the floor and in the fuel canisters. The sludge consists of corrosion products from the fuel, from rusted racks and from canisters which hold the fuel. The actual composition varies widely from one part of the basins to another. It is anticipated that the sludge will have to undergo some form of treatment prior to being sent to storage. Treatment may be required for components in the sludge including the reactive unoxidized metallic uranium. Currently there is a need for large quantities of sampled sludge that must be collected in a manner that protects workers from dose exposure. The challenge is obtaining sufficiently large samples of sludge through grating which is suspended over water, twenty-one feet above the sludge-covered basin bottom.



Above: Sludge sampler mechanism collects samples from containers under water in K Basin. Inset: Underwater close-up view of spent fuel in canisters with sample probe inserted to gather sludge.

Current Approach

In the past, small samples of sludge have been retrieved for characterization of chemical and physical properties. Laboratory scale investigations of treatment technologies have also been performed. Initially, sludge was collected in grab sample bottles with little control over sample recovery. Subsequently, an apparatus called the “single pull” sampler was utilized to collect sludge. This device allowed the collection of sludge from a single basin location. Sludge was pumped into bottles above the surface of the pool. The amount of sludge collected was limited by the radiation hazard presented by the material and by the fact that, because of the pumping action, large amounts of extraneous water were added to the sludge. Typically, the amount of actual sludge recovered was a few hundred milliliters per sample.

Benefits and Features

- ◆ Sludge from several locations can be consolidated into one composite sample
- ◆ Sample containers remain underwater, providing improved worker protection shielding
- ◆ Large amounts (liters) of sludge can be collected in a single sample
- ◆ Minimal excess water is added to sludge during the collection process

New Technology

The new consolidated sludge sampling apparatus accumulates the sludge in a container that remains underwater during operation, thereby allowing highly radioactive sludge to be collected in large amounts with no hazard to operators. The pump, which produces a necessary suction, resides underwater, reducing the need for several safety features that previously were added to ensure that accidental discharges of sludge did not occur near personnel. The ability to start and stop the operation during sludge collection is a feature that allows the movement of the collection wand to multiple basin locations while feeding a single sample container. A micron-sized filter was added to the exit port of each sample container. This allows excess water to escape while trapping sludge particles. The capability to back-flush the filter also exists.

The sludge sampling device has been deployed at the K-East Basin and has successfully collected samples ranging from two to three liters from both the basin floor and fuel storage canisters.

This technology provides worker safety (As-Low-As-Reasonably-Achievable – ALARA) benefits and enables the collection of larger sludge quantities at a reduced cost.

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Integrated Water Treatment System (IWTS)

The Challenge

The Hanford Spent Nuclear Fuel (SNF) Project is preparing to move a large amount of metallic uranium SNF from the existing K Basin pools into dry storage. This fuel was originally irradiated in the Hanford N reactor and has been stored underwater for a number of years at a location near the Columbia River. The movement and packaging of the fuel will initially involve a number of underwater processes such as cleaning and sorting. During these processes, the accumulated loose product of years of fuel corrosion will be disturbed. Additionally, the processes themselves will create fresh particulate since the frequency and severity of remote handling operations will be significant. An uncontrolled cloud of particulate and soluble materials would have adverse consequences from the point of view of contamination spread, radiological dose to operators, and visibility in the underwater work zone. The challenge is that any device or series of devices designed to mitigate these effects, besides being effective at removing variously sized particles, must perform in a critically and radiologically safe manner and in a manner that does not accumulate hydrogen. Hydrogen gas potentially may be generated when newly created metal particulate comes in contact with water.



Some of the IWTS equipment components: Left – filter vessels, above – filtration booster pump skid

Current Approach

No movements of N reactor fuel have been attempted on the scale now planned for the near term in K Basins. This fuel consists of approximately 100,000 elements stored in stainless steel canisters. In the last several years, movements of smaller batches of fuel canisters and movements of over 200 fuel elements have occurred as part of the fuel and sludge characterization activity. Observations made when canisters are opened and observations made when fuel elements are moved have shown that the canisters do contain significant amounts of sludge and that the sludge will trail into the basin when elements are handled. Sampling of water contained in the canisters has demonstrated the presence of significant amounts of radionuclides and hydrogen which will be released to the basin during the anticipated processing. Chemical analysis of the sludge has shown the presence of many constituents including oxides of uranium and hydroxides of

Benefits and Features

- ◆ Traps soluble and particulate emissions
- ◆ Reduces the spread of contamination and improves water clarity
- ◆ Traps a variety of particle sizes
- ◆ Is compatible with the handling of reactive metal particles

aluminum and iron. Particle size determinations in the laboratory show a wide range of sizes and a wide range of settling times.

New Technology

The Integrated Water Treatment System (IWTS) has been installed to remove radionuclides and particulates from the K Basin water. The system is a four-stage water filtration system consisting of three submerged pumps, a knockout pot, ten settling tanks, three filtration modules and three ion exchange modules with associated structure and piping. The system has been deployed in the Hanford K-West Basin. Expected feed rate is 320 gallons per minute at a system pressure of 112 psi. Suspended solids entering the system are expected to be approximately 20.8 mg/l with a maximum of 375 mg/l.

The pumps suction material from the Fuel Retrieval System (FRS) with one pump dedicated to each of the major subsystems of FRS. The knockout pot (33 inches tall and 16 inches diameter) consists of 7 successive layers of baffle plates arranged at 30-degree angles. Particles smaller than 0.5 mm are expected to be trapped here.

Flow then proceeds to the settler tanks each 20 in. diameter and 192 in. length and a capacity of 1 cubic meter. The densest portion (50 percent) of the remaining particulate is expected to be removed at this step and is expected to include

any remaining metallic fuel particles. Hydrogen gas that may be generated flows back to the basin water and not to locations where combustible mixture with air is possible.

The remaining particles are then removed during a filtration step followed by a reduction of the soluble radionuclide content through the use of ion exchange modules. This technology will improve water clarity and trap most particulates in the water.

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TM-DEP-99-011



Enhanced Thermo-Gravimetric Analysis (TGA) Instrument

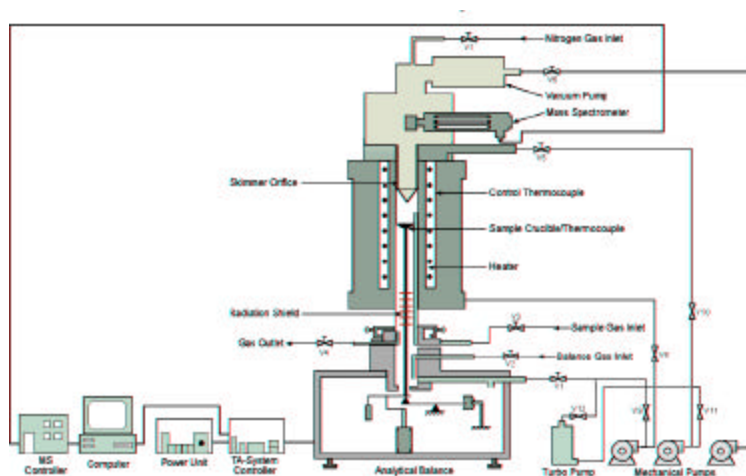
The Challenge

A method is needed to measure the oxidation rate and the rate of water evolution (drying) at various temperatures for samples of N Reactor fuel and associated sludge. Such an apparatus should have the ability to detect oxidation by weight gain and water evolution by weight loss. The detection of other evolved gases, such as hydrogen and fission gases, which may elucidate chemical reaction mechanisms, is also desirable.

Irradiated N Reactor spent fuel has been stored in the water-filled Hanford K Basins for more than 15 years. A concerted effort is underway to move this fuel away from its current location near the Columbia River. The fuel will be placed in Multi-Canister Overpacks (MCOs) which will, in turn, be placed in interim storage at the Canister Storage Building after fuel drying is accomplished. Since much of the fuel is currently in a fractured condition and significant uranium fuel surface area is exposed to the surroundings, understanding the rate of reaction of fuel with oxygen and moisture is important for safety analysis calculations. Such oxidation reactions are a source of chemically-produced heat which must be carefully balanced against the surrounding heat removal capability during the various stages of drying and storage. Furthermore, since the drying process will take place at relatively low temperatures, it is inevitable that some amount of residual water will accompany the fuel into interim storage. This includes both water bound to the fuel itself, and water contained in sludge which may be trapped in the cracks associated with breached fuel. Quantification of the kinetics for release and decomposition of this water is important to the future pressurization of the MCOs as they sit in storage.

Current Approach

The initial attempts to quantify the oxidation behavior of N Reactor fuel were performed in a small clam-shell furnace where the depletion of oxygen in the flowing gas stream was taken as an indication of oxygen uptake by the sample. Measurement of this oxygen depletion via a gas chromatograph was not nearly as accurate as a weight measurement would be and some of the oxygen depletion could be ascribed to uptake by the furnace structure



A Schematic of the TGA/MS/DSC System

Benefits and Features

- ◆ Continuous weight change measurement for large samples and extended operating temperature range
- ◆ Operates in vacuum, moist and dry gas environments
- ◆ Glove box installation for control of contamination
- ◆ Built-in mass spectrometer for gas composition monitoring

rather than the sample. The drying behavior of sludge was initially studied using very small samples (milligram quantities) in an inferior thermo-gravimetric analysis (TGA) instrument which had no capability to attain vacuum conditions and no capability to analyze gases driven off from the sample. This less-sophisticated instrument was installed in a fume hood which limited the ability to control contamination from large quantities of radioactive particulate and fuel.

New Technology

An enhanced TGA instrument with the capability to run gram-size samples enabled the analysis of macroscopic pieces of N Reactor fuel. This is a significant improvement since smaller microgram samples may not always contain the inhomogeneities which can initiate rapid oxidation. The temperature capability ranged from 70°C to 1000°C and vacuum operation is routine. The instrument also included a mass spectrometer capable of monitoring a wide range of atomic and molecular masses. The instrument was installed in a glove box (to control contamination spread).

The capability to introduce moist gas was attained through the addition of a bubbler and flow controller. Gas inputs were rerouted so as not to introduce moist gas (condensate) into the balance section of the instrument. A moisture monitor was added for more accurate gauging of the gas water content. An oxygen monitor was also added since oxygen additions have a known effect on the ability of water to oxidize uranium.

The instrument has been successfully used to demonstrate the degree to which irradiated N Reactor fuel (a uranium alloy) follows the correlations published in the literature for

oxidation rate in dry air, moist air, and moist helium. This has led to increased confidence in the use of these correlations and the safety factors applied to these equations during design activities.

The TGA instrument has also been used to dry sludge recovered from both the bottom of K Basin fuel canisters and from the subsurface cracks in fuel elements. Here, vacuum conditions are important to exactly match the vacuum drying conditions that the fuel will see during processing. Coatings taken from the surface of fuel element cladding have also been run. The kinetics of water release from these hydrated materials, with increasing temperature, have been determined thus improving the understanding of the drying process and the knowledge related to residual moisture.

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TECHNOLOGY DEPLOYMENTS

RIVER PROTECTION PROJECT



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RTD Pit Leak Detectors

The Challenge

Hanford Tank Farm facilities include several hundred valve pits, diversion boxes, clean-out boxes and miles of underground piping for the transfer of radioactive waste. A 30-year-old Hanford leak detector design is currently used to provide alarm indication if a leak occurs during a waste transfer. Each pit or box contains a leak detector. The design was generated at Hanford and the leak detectors were assembled onsite because they were not commercially available. Each leak detector unit has many components, any one of which could create a system failure.

The leak detection system must be accurate and reliable. To ensure a clean operating environment for the workers, a fast leak detection response time is necessary. Any leakage of radioactive waste can have dose consequences for workers and, in some cases, the waste may be permanently absorbed into the concrete surfaces if not cleaned and/or rinsed.



Above – leak detectors are located through shielding surface openings to detect leakage on the floor surface below. Left – leak detector element sensor and cable.

Current Approach

The active baseline leak detection systems utilize a sensor head with two probes. As waste or water comes into contact with the two probes in a pit or a diversion box, the material provides an electrical pathway for the sensing circuit to be completed. The sensing pathway must be intrinsically safe due to flammable gas concerns. The existing system requires a high degree of maintenance. In addition, false alarms from rainwater intrusion and component failures have degraded the reliability of this critical system. A significant effort (operations, maintenance and engineering) is required to maintain this site-wide detection system.

New Technology

The Cross-Site Transfer System Project design included a proven technology using a Resistance Temperature Device (RTD) leak detection system. The sensing head has two RTDs; one is the active unit while the other is the reference unit. The detector electronics operate on a simple circuit comparison method. When the sensor head becomes wet, the difference between the two sensors is

Benefits and Features

- ◆ Reliable and repeatable performance
- ◆ Commercially available off-the-shelf equipment
- ◆ Low maintenance
- ◆ Intrinsically safe operation

almost non-existent. When the sensor head is dry there is a large difference between the two sensor readings. The detectors are stable and the sensing of liquid requires less than 60 seconds to respond to a leak. The detector's performance is predictable and repeatable.

The Diversion Box (Building 6241-A) and Vent Station (Building 6241-V) both have lined floors that are sloped towards a sump. The sump in each building has redundant RTD leak detectors that operate in support of the Cross-Site transfer line activities. The RTD detectors provide a shutdown of the cross-site transfer pump upon detection of a leak.

The RTD sensors and electronics units are used in various Nuclear Power Generating Stations throughout the United States with great success. This technology has now been applied within the River Protection Project and may have application elsewhere within the Department of Energy complex.

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TM-DEP-99-005



Slim-Hole Neutron and Gamma Probes

The Challenge

Hanford double-shell waste tank SY-101 is one of the site's most pressing safety concerns. Its concentrated waste generates higher than average gas volumes, most of which is flammable or explosive. The waste surface has been rising at a faster-than-normal rate since early in 1997 and is approaching the maximum allowable tank level. The reasons for this accelerated surface growth are not fully understood and it is not known whether the slurry level is remaining relatively constant and only the crust is expanding, or if the entire waste volume is growing. It is known, however, that there is a surface crust overlaying a foamy, gaseous layer. This gaseous layer rests on top of the liquid waste slurry but, because of the gaseous crust, the exact depth of the liquid slurry cannot be directly measured by conventional means. It is very difficult to measure the true liquid level in the tank or the resulting thickness of the gaseous crust. Resolving these safety issues and preparing to safely transfer the waste out of the tank depends on resolving these issues.

Current Approach

The conventional method for measuring tank waste liquid levels below a solid crust employs a neutron and gamma probe that is inserted into a Liquid Observation Well (LOW). The LOW is a hollow fiberglass tube sealed at the bottom that is inserted into the waste, providing an uncontaminated environment to perform waste volume surveys. From the probe response, one can determine the liquid interface within the waste structure, along with other important tank features of interest. Surveillance vans capable of obtaining both neutron and gamma probe data are currently used in about 60 tanks. Unfortunately, SY-101 was not fitted with a LOW and one could not be installed because of overriding safety concerns. There are a limited number of tank riser openings available for new instruments in this tank. There are, however, two existing Multi-Instrument Trees (MITs), installed in the tank. The MITs are about four inches in diameter, with a two-inch hollow center opening that is sealed at the bottom. A "validation probe" can be inserted into the center of the MIT, providing a relatively accurate temperature profile. Since the vapor space and gaseous crust are cooler than the liquid waste, two distinct temperature trends can be identified, and the intersection of these two trend lines approximates the actual liquid slurry level. Measurements with validation probes are time consuming and the probes are expensive to install and remove. This method provides only a rough estimate of the liquid slurry level based on the resulting temperature trend.



Tank Farm operator inserting probe in MIT. The probe is connected by a combination steel-support and data transmission cable to the LOW van (background) containing data-logging equipment.

Benefits and Features

- ◆ 100% compatible with existing equipment
- ◆ Accurately tracks waste profile changes
- ◆ Faster, more accurate, and less expensive than previous methods

New Technology

The interior opening of the MIT is similar to a LOW, although much smaller. The neutron and gamma probes used in routine LOW logging could provide the waste and liquid interface information needed, but they are too large to fit into the MIT. The builder of the original LOW surveillance equipment, Greenspan Inc., Houston, Texas, was contracted to build slim-hole versions of the probes that would be 100% compatible with all the existing surveillance equipment and software, but having an outside diameter to fit the narrow opening in the MIT. The new probes generate slightly lower count rates than the full size versions; however, the nuclear statistics meet monitoring requirements without compromising data accuracy or sensitivity.

The new equipment is compatible with the existing equipment to the extent that the operating procedures do not need to be modified. The data from the new probes clearly identified the top of the liquid slurry, the location of the tank bulkhead spacing rings, the gaseous interval just above the liquid, and the elevation of the surface crust. Surveys are being conducted weekly to track changes in the waste profile

features, and the accuracy of the measurements is greatly improved and less expensive than the previous validation probe method. The new probes are providing critical information helping to resolve the important tank waste volume safety issue. This technology also will enable continued planning for the pumping of tank waste and lowering the surface to a safer level.

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TM-DEP-99-007



Saltwell Portable Exhauster

The Challenge

Hanford has 149 single-shell waste tanks (SSTs) that contain high level radioactive waste. Some of these tanks contain free liquids which are being transferred to safer double-shell tanks in a process called “saltwell pumping.” A number of these SSTs have been identified as having the potential for producing flammable gases. The gases are generated primarily by radiolysis of water contained in the waste and then released into the tank dome space during steady state and episodic events. Release of flammable gas, if not diluted, could create the potential for flammable/explosive concentrations within the tank.

To reduce the risk, exhausters are required to remove the gases by drawing air into the tank and sweeping out flammable gas. Since the potential concentrations of the flammable gas could be well above the 25% Lower Flammability Limit safety limit, the exhauster equipment in contact with the “wetted” air stream must be qualified to operate in a flammable gas environment. This includes meeting the Tank Waste Remediation System (TWRS) Authorization Basis Ignition Set Controls, as well as the National Fire Protection Association (NFPA) hazard classifications.



Side view of a portable exhauster located in a tank farm. Temporary scaffolding is erected around the vent stack.

Current Approach

SSTs are ventilated either by permanently installed active ventilation or by passive ventilation through HEPA filtered tank openings. The permanently installed existing tank ventilation systems provide tank headspace air changes that remove flammable gas and maintain particulate confinement. However, the aging active SST ventilation systems require high maintenance and do not have features to ensure the HEPA filters are operating as required. Since these systems are ventilating more than one tank at a time, they are not required to meet the flammable gas controls identified in the TWRS Authorization Basis.

Benefits and Features

- ◆ Flammable gas qualified with safety interlocks
- ◆ Skid-mounted and portable
- ◆ Suitable for multiple tank farm locations
- ◆ Programmable logic controller

Passive systems consist of a HEPA filter and HEPA filter housing located on the top of a riser attached to the tank. Ventilation is provided by the changes in temperature and atmospheric pressure causing the tank to “breathe” naturally. The flow rate associated with passive ventilation is very low and is not adequate to support saltwell pumping.

New Technology

A portable exhauster is now being used to support safe operations during saltwell pumping. It was designed and constructed to meet the most stringent flammable gas controls as prescribed by the NFPA criteria for Class 1 Division 1 Group B. The Continuous Air Monitor (CAM) located in the stack of the exhauster meets the applicable Ignition Set Controls.

The entire system was designed with flexibility that allows it to operate in different field conditions and tank farm locations, including a wide variation of flow rates and varying physical placement in the field. Tank farms have a variety of sloped and flat terrain and are cluttered with aboveground equipment and facilities that support operation of the underground tanks. The skid-mounted exhauster system includes self-leveling jacks and a programmable logic controller (PLC) for total system control and data communication to the remote operator control room. Exhauster instrumentation is centrally located to facilitate efficient data gathering. A shrouded probe instrument on the ventilation stack is an innovative technology that extends the range of stack flow rates that can be sampled, and meets the new ANSI standard for stack sampling. The HEPA filter housing is designed to allow independent testing of each filter as required by ASME N510 criteria.

Communication links between the portable exhausters and the saltwell pumping equipment

ensures alarms, shutdowns, and safety pump interlocks are promptly recognized in the operations control room. Tank pumping is terminated prior to ventilating to protect against a spray leak accident in the transfer piping system. Such a leak could be carried into the exhauster by airflow, saturating the HEPA filters and possibly resulting in nearby or off-site contamination.

The portable exhauster provides an intrinsically safe flammable gas qualified system for all tank farm applications, positive flow evacuation rates with measurable flow quantities, approved HEPA filtration and important instrumented control data for accurate and reliable operations.

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Fluor Daniel Hanford, Inc., Technology Management
TM-DEP-99-003



Enraf Annulus Leak Detector

The Challenge

The Hanford Site contains 177 cylindrical underground storage tanks that contain 55 million gallons of hazardous and radioactive wastes. The tanks are reinforced concrete structures with inner carbon steel liners. Tanks are split into two groups based on their design: 149 tanks have a single carbon steel liner and 28 tanks have two steel liners separated by a space called the annulus. The annulus provides a margin of safety in the case of leaks because the leak can be detected and the waste removed before it might escape. The annulus is roughly a 30-inch wide space surrounding the 75-foot diameter primary inner tank. The bottom of the tank is approximately 56 feet below ground. The Washington State Department of Ecology (WDOE) requires that an accumulation of 0.5 inch or less of liquid in the bottom of the annulus be detectable. Temperature changes within the annulus, coupled with the extreme depth and inaccessibility of the tank make for difficulties in identifying reliable technologies that are not affected by atmospheric and environmental changes. The challenge is finding a device that is reliable, accurate and simple to implement.



An Enraf level gauge leak detector with custom designed displacer suspended by a thin metallic alloy wire.

Current Approach

The technology currently used to detect leaks into Hanford's double-shell tank annuli is conductivity based. A plummet – or steel plumb bob – is suspended from a manually adjustable flat steel tape at approximately 0.5 inch above the annulus bottom. Should liquid be introduced into the annulus, an electrical circuit is completed after it touches the plummet. Relays then activate various audible and visual alarms, notifying operators that a leak has occurred.

Widely varying temperatures within the annulus often cause thermal expansion to occur within the steel tape attached to the plummet. The expansion/contraction can either cause false readings, or set points greater than 0.5 inch.

Many of the newer model devices are fabricated from thick polycarbonate plastic sheets assembled with adhesive cement. Exposure to ultraviolet radiation from the sun turns the adhesive to powder, thereby causing the devices to fall apart. Replacement of these devices is cost prohibitive requiring custom fabrication and assembly, since they are not commercially available.

Benefits and Features

- ◆ More accurate leak detection
- ◆ Reliable operation
- ◆ Technicians already familiar with the instrument
- ◆ No guess work with set points
- ◆ Remote alarming capability

New Technology

The Enraf™ Series 854 ATG (Advanced Technology Gauge) is a level detector that has the capability to track level changes in liquids and solids. These level detectors are being deployed on double-shell tank annuli. The Series 854 ATG is widely used throughout the tank farms for primary tank waste surface level measurement. Deploying the Enraf™ as an annulus leak detector is a logical extension of its capabilities.

The gauge operates on the principle of buoyancy to track level changes within the tank. A plummet – referred to as a “displacer” – is lowered into the tank until it encounters an upward force, such as from a liquid or solid, at which point it stops. The instrument tracks the position of the displacer and reports the level of the encountered liquid or solid.

In the annulus leak detection mode, the displacer rests on the bottom of the annulus, waiting for liquid to rise beneath it. A certain amount of liquid must enter the annulus before the gauge can detect the upward force. The amount of liquid necessary to lift the displacer from the floor of the tank annulus is approximately 0.19 inch. The instrument has an accuracy of ± 0.04 inch and a repeatability of 0.004 inch.

Deployment of the Enraf Annulus leak detector, compared to the baseline method, minimizes operator judgement, and results in more accurate data and reliable performance. Deployment was

initially in tank 101-SY and planned for other DSTs. Additionally, technicians and engineers are familiar with its functional capabilities, operation and maintenance. Therefore, little or no additional training will be required. The technology achieves the regulatory requirement for leak detection in the tank annulus and provides an alarm in the event of a detectable leak.

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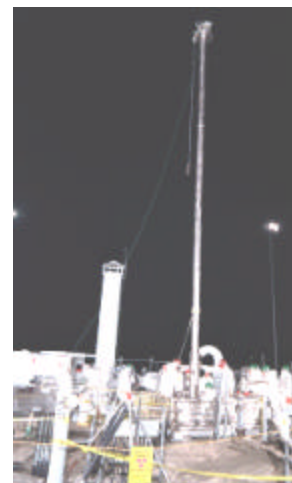
New Generation Transfer Pump

The Challenge

The River Protection Project employs transfer pumps to move the hazardous nuclear waste in the form of either slurry or supernate between tanks. In 1992 the Environmental Protection Agency issued the "Debris Rule" that had a major effect on how mixed radioactive waste is handled at Hanford. This rule requires, that for environmental compliance, any equipment being buried must be decontaminated to a "low level waste" category prior to burial.

Previously, equipment was buried as removed from the tank with minimum decontamination. The new requirement increased the cost of disposal to a point where the current design approach for transfer pumps needed to be reevaluated to control disposal costs through improved equipment design and operation.

It is projected that transfer pumps will have to move 509 million gallons of waste from 1999 to 2027. Using the current pump technology, over 200 pumps would be required to perform this task. Using the New Generation Transfer Pump (NGTP) technology, only 46 pumps would be required, resulting in a significant cost avoidance.



Fifty-foot-long pump and discharge column suspended by a crane while being lowered into 101-SY. Integral pump/meter unit (left) being inspected by a worker prior to installation.

Current Approach

Vertical turbine pumps, originally designed for agricultural use, are used at Hanford to transfer waste, demonstrating low reliability and operating for only an average of 400 hours before failure. The apparent cause of the premature failure was usually related to seizing of the product lubricated bushings that support the long line shaft or failure of the pump shaft itself resulting from excessive torque. Because of the low pump cost and the relative ease of disposal, this scheme worked for many years. The highly radioactive service meant that pump maintenance or refurbishment was out of the question. Therefore, it was far less expensive just to remove and bury the failed unit and replace the pump.

The current technology lacked the versatility to meet all of the transfer pumping needs at Hanford. The units operated at a fixed speed that resulted in a wide variation in flow rates, depending on the specific transfer route length and conditions. Low flow rates, occurring when there were high head losses from long transfers, contributed to premature pump failure and to transfer line plugging.

In addition, the current technology uses cast iron and carbon steel materials that are more difficult to decontaminate when the equipment service life is over.

Benefits and Features

- ◆ Extended pump operating life
- ◆ Significant cost avoidance
- ◆ Simpler to decontaminate when ultimately removed from the tank for disposal

New Technology

The New Generation Transfer pump is a submersible, centrifugal, two-stage combination pump and motor. The motor is cooled and lubricated by the pumped fluid and is designed to withstand both the temperatures and radiation fields found in the Hanford waste tanks. It is the first of its kind for this service, focusing on reliability, extended life and reduced disposal costs. However, it is a blend of proven technologies and designs from other pump applications, i.e., U.S. Navy Nuclear Reactor Coolant pumps. The projected design life is 10,000 hours of running time over a 10-year period.

Based on the experience with the current technology and the need to address the premature failures, operability problems, the expensive decontamination, and lack of versatility, DOE authorized the New Generation Transfer Pump Program in 1993 to design a pump to achieve four principal goals. This pump was designed, built and tested in a manner consistent with the four goals summarized below:

- 1) Life extension - The components of the NGTP subject to high wear because of the abrasiveness of the pumped fluid were wear-tested using a simulant of the Hanford waste. This included the product-lubricated bearings and other high velocity areas of the pump. The testing results supported a 10,000-hour pump life at maximum speed compared to the 400-hour pump life of the old technology.
- 2) Improved design to reduce disposal costs - The pump and motor were built using austenitic stainless steel to facilitate decontamination and the design was specifically done to eliminate locations where waste could collect. Clear plastic models of the pump were constructed to develop the best possible internal flushing system to minimize potential plugging. The external surface of the pump was machined to a smooth finish to enhance the ability to decontaminate the outside of the pump during removal.

- 3) Improvements in pump operability - These were demonstrated by the performance testing at Savannah River, the pump factory in Pittsburgh, Pennsylvania, and the Hanford run-in testing done at Sulzer Bingham Pumps, Inc. in Portland, Oregon. All of these tests confirmed that the pump met the specified performance requirements.
- 4) Universal waste transfer capability - The NGTP was demonstrated through testing of the variable frequency drive during all of the performance testing. The pump and motor were run at a wide range of speeds from 1686 rpm to 3900 rpm. In addition to demonstrating the versatility of the pump, this testing verified the vibrational stability of the unit under all operating conditions.

The initial pump and motor are being installed in the SY-101 Waste Tank at Hanford as part of the Expedited Waste Transfer Program. It will be used to reduce the fluid level in the SY-101 tank by transferring slurry to the adjacent SY-102 tank.

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TM-DEP-99-012



Sidewall Sampler for Characterizing Tank Farm Vadose Zone

The Challenge

Historical waste leaks from the Hanford Single-Shell Tanks (SSTs) have resulted in radiological contamination of the underlying sediments in the vadose zone. Quantitative and qualitative data are required to understand the potential mechanisms, locations, and quantity of contamination in the vadose zone to support decisions regarding SST retrieval and tank farm closure. These sediments have not been fully characterized due to the potentially high radiation fields and dose rates associated with handling these materials. An efficient and lower cost means is needed to physically sample the vadose zone and characterize this hazardous environment.

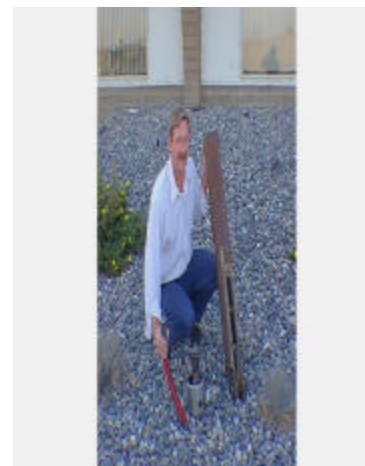
Current Approach

Vadose zone sediment samples are obtained by either drilling or driving a borehole to a predetermined depth and then deploying a sampling device to sample the sediments ahead of (below) the advancing borehole casing.

During the drilling process either continuous sampling is employed or sample locations are selected prior to the start of drilling. Extensive procedures are used to contain and control the sampling activities. Continuous sampling results in excellent geologic control and full capability to monitor small, but potentially important aspects of contaminant distribution. Continuous sampling does, however, subject workers to potentially harmful radiation exposure due to the physical size of the sampler needed to penetrate the Hanford sediments. Sampling in this manner is a high cost approach. Sampling at predetermined locations introduces a significant risk of missing those portions of the vadose zone that would yield the most valuable and useful information. Drilling of new wells is costly, results in generation of large quantities of waste and provides an additional pathway for contaminants to move.

New Technology

Two sidewall-sampling systems, a primary and a backup sampler, were developed to collect small diameter (low dose-rate) samples from the sidewall of boreholes as the bores are decommissioned. As a borehole is being decommissioned, the casing is removed while filling the resulting void with bentonite (a naturally occurring clay material) or cement to seal the borehole and prevent future movement of contaminated water down the bore. Sampling locations are selected based on gross or spectral gamma geophysical logs of the borehole.



In the person's right hand is the sidewall rotary coring (primary) sampler and in his left hand, the spring-loaded arm sampler (backup).

Benefits and Features

- ◆ Supports As-Low-As-Reasonably-Achievable (ALARA) objectives
- ◆ Enables program to collect and analyze sediments from specific, targeted zones
- ◆ Reduces waste generation
- ◆ Provides opportunity to significantly reduce programmatic costs
- ◆ Supports risk assessments

The sidewall samplers are both actuated using a drilling machine. The first system is deployed using a rotary coring device and downhole deflector. The second system uses a spring-loaded arm to deploy the sampler, which is driven into the formation as the drill rods are extracted.

For the first system a television survey is again utilized to inspect the borehole to a depth below the casing. This allows the pointed sampler to swing out to contact the borehole wall at a shallow angle. The downhole deflector is then carefully set into position (vertical and azimuth orientation). The sampler is then lowered into the downhole deflector, rotated and advanced into the surrounding formation. The sampler can be advanced into the formation about 20 cm, cutting a core as it advances. The sampler is then disconnected from the drill rod and deployment device and sent to the laboratory for analysis. Only limited success was attained using this sampler; engineering design changes are underway. This design is projected to be useful in fulfilling future tank farm sampling needs because of the ability to precisely locate and direct this sampler and the rotational method used to gather the sample.

For the second system the sampler is lowered into the borehole to the backfill. A trip is actuated when a foot on the sampler contacts the bentonite backfill causing the sampler to swing outwards contacting the borehole wall at a shallow angle. As the drill rod is raised the sampler is driven into the formation, capturing a 1.25-in. to 4-in. square sample. As the drill rod continues to be lifted, the sample tube is pulled from the formation and drops parallel to the drill rod. The sampler is removed from the borehole, disconnected from the drill rod and sent to the laboratory for analysis of its contents. The simplicity of this sampler allows for efficient operation. This system successfully and safely retrieved vadose zone samples with a

contact radiation dose of greater than 3 R/hour. However, this sampler cannot be located in the borehole as precisely as the rotary core sampler, and the entry orientation of this sampler itself is not as precisely controlled.

Both sidewall samplers have been deployed in the 241-SX Tank Farm to collect samples from a borehole that has exhibited the deepest movement of cesium-137 found to-date. Samples derived from this effort are being analyzed to determine the geochemical nature of this deep movement and to determine if other, more mobile contaminants such as technetium-99 have moved ahead of the cesium-137. Sampling and analysis of the highly contaminated zone will yield previously unknown information on the geochemical interactions between the sediments and the hot, highly caustic tank wastes. This sampling technology will provide reduced cost vadose zone data for tank farms.

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TM-DEP-99-013



Enraf Densitometer in Tank AY-102

The Challenge

The Hanford Site contains a number of tanks that store high-level radioactive waste. One of Hanford's high-level waste tanks (C-106) is a concern because the waste solids that have settled on the floor of the tank generate more heat than the tank was designed for. To resolve this concern, waste is being transferred to double-shell tank AY-102 (receiver tank) that can accommodate the heat. The waste cannot be transferred all at once, however, because the settling and heat-dissipation characteristics of the heat-generating solids are not well understood, and there is a potential to create a new heat problem in the receiving tank. The mass of waste solids transferred in each batch must be carefully monitored so that a heat problem does not occur during transfer or storage in the receiver tank.

Verification of the mass of waste transferred requires an accurate measurement of the sediment level in the receiver tank. The challenge is to find technologies that can easily and accurately measure the fluid density and the sediment level.

Current Approach

The primary instrument used to measure the solids transferred is a commercial coriolis mass flow meter. This method requires knowledge of the liquid density, and this density can change significantly during the waste retrieval and transfer process.

The liquid density is measured in a laboratory using grab samples taken from the waste storage tanks to determine chemical composition and physical properties, including fluid density. The sampling and analysis requires numerous laboratory and field activities; some involving exposure of personnel to radiation, and some involving efforts to minimize the amount of mixed waste generated.

Sediment level is measured by taking manual measurements using a sludge weight consisting of a 4-inch diameter steel "doughnut" suspended either by a calibrated tape, or by a cable lowered until it encounters increased resistance or comes to rest on the settled solids layer at the bottom of the tank. Based on the elevation at which the sludge weight



An Enraf gauge housing that mounts to a tank riser flange. A stainless steel displacer suspended from the gauge makes contact with tank waste.

Benefits and Features

- ◆ Determining interface level is accurate and repeatable
- ◆ Lower cost than the baseline sludge weight method
- ◆ Reduced operation exposure
- ◆ Real-time in-situ density measurements
- ◆ Elimination of operator judgement to establish the interface level

comes to rest, a sediment level can be determined. However, this method is not very sensitive and subject to wide variation. Detecting the point where increased resistance occurs or where the sludge weight comes to rest relies on operator judgement.

New Technology

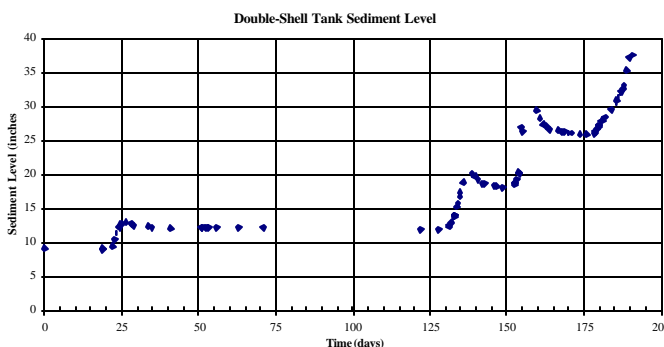
An Enraf™-Nonius Series 854 ATG (Advanced Technology Gauge) equipped with custom software to measure tank density profile has been installed on the receiver double-shell tank. The instrument is capable of accuracy of $\pm 0.005 \text{ g/cm}^3$ in the density profile mode and an accuracy of $\pm 2 \text{ mm}$ in the interface sludge sediment measurement mode.

The densitometer is operated from a remotely located instrument building through the Enraf™ gauge communication interface unit and a host portable computer. If necessary, measurements can also be made locally with a portable Enraf™ terminal via an infrared optical port integral to the gauge.

Measurement of the mass transfer during the retrieval process utilizes the coriolis mass flow meter. Knowledge of the starting initial fluid density in the receiver tank waste can be easily determined by the Enraf™ densitometer. Because the density can be measured in-situ, the cost, turn-around time and safety concerns associated with sampling and analyzing the radioactive chemical waste are reduced, and the accuracy is significantly improved.

The additional interface level feature of the Enraf™ densitometer has been implemented in procedures for verifying the mass of waste transferred during a retrieval operating run. This feature of the densitometer measures the sediment level in the receiver tank after the completion of the retrieval runs. As the sludge waste in the single-shell tank is transferred, the sediment level in the receiver tank increases after each run and

then decreases as the solids settle over time. This sediment data is combined with separate data on the fraction of solids that dissolve in the tank supernatant liquid to arrive at a measure of the mass of waste transferred out of the single-shell tank that can be compared with the values based on the coriolis mass flow meter to verify total amount of waste transferred. Deployment of the Enraf densitometer, compared to the baseline method, minimizes operator judgement, is safer and more cost effective, and reduces operator exposure by eliminating field activity for data-gathering.



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TM-DEP-99-002

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New Generation Continuous Air Monitors

The Challenge

The Hanford double-shell and some single-shell waste tanks have active forced-air ventilation systems to provide cooling and radiological contamination control. For the protection of personnel and the environment, the exhaust streams from these systems are monitored for potential release of radioactive contaminants. In addition, the vent stream of each tank annulus (space between the shells of a double-shell tank) is monitored ahead of the integral filtration systems for the presence of radioactive contaminants. The presence of contaminants in the tank annuli would be an indication of a potential loss of primary waste tank containment (leak). The instrument commonly used for this monitoring is a Continuous Air Monitor (CAM).



New AMS-4 CAM instrument display and the remote computer monitor (inset).

Current Approach

The monitoring system consists of a sample collection probe, sample lines for air sample transport and a vacuum pump for motive force. The CAM collects particulates on a filter inserted into the sample air stream that is, in turn, monitored by a radiation detector. The filter serves to accumulate or totalize particulates and concentrate any contaminants in the sample stream. The CAMs presently in service in the tank farms are Eberline Model AMS-3 and are based on old technology. The radiation detectors are Geiger-Mueller (GM) tubes that are unable to discriminate gamma radiation from beta particles which is the radiation of primary interest. Heavy lead shielding is used to prevent unwanted background gamma from entering the detector and this results in an instrument that weighs 160 pounds. Since the CAMs are removed once per year as a minimum from the field for calibration, this presents a safety hazard to the worker when lifting the CAM from the vertical storage racks. In addition, the electronics provide only a single measurement parameter – total filter counts per minute. This measurement does not consider the rate of radionuclide deposits or the short-term collection concentration in the sample stream. There are no statistical calculations performed on the data to determine significance before being able to make decisions on alarm set points. Alarm functions with the existing AMS-3 CAM are limited to high radiation level and detector failure.

Benefits and Features

- ◆ Resolves employee safety concern (heavy lifting)
- ◆ More reliable operation and increased accuracy
- ◆ Reduced calibration time
- ◆ Increased visibility for equipment problems and off-normal conditions
- ◆ Remote interrogation of CAM status

New Technology

The existing CAMs are being replaced with Eberline Model AMS-4 CAMs. The new instruments utilize microprocessors to provide statistical analysis evaluation of the data to determine significance before making alarm decisions. The detectors are capable of discriminating between gamma radiation and beta particles. The detectors do not require heavy lead shielding to block the background gamma radiation. The CAM has a remote in-line detector unit that can be separated from the electronics and readout display. Each unit weighs less than 10 pounds compared to 160 pounds for the current CAMs and is much safer for workers when lifting during maintenance and annual calibration.

The new CAMs incorporate a mass flow sensor and measure the flow rate of the sample stream passing through the detector chamber. The flow rate and the rate of change of radiation on the filter are used to calculate actual sample stream concentrations of radioactivity. The measured radiation can be displayed as the total accumulated amount on the filter or as a concentration in the stream. The concentration measurements have user-selectable time duration constants. The user can select any or all of the measurements for radiation alarm set points. A separate instrument failure alarm is also composed of user-selectable parameters

including detector failure and low sample flow rate. A computer port allows remote interrogation of the unit's status. All user-selectable parameters can also be modified via a remote work station computer. Calibration of the detector is done under internal processor control and can be performed in much less time than with the old technology. A calibration report is also available upon request via a printer port for convenience in maintaining the instruments. The remote computer workstation has not been implemented but provides an opportunity for additional future system enhancement and cost savings.

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Fluor Daniel Hanford, Inc., Technology Management
TM-DEP-99-008



Continuous Length Leak Detector

The Challenge

Hanford Tank Farm facilities include miles of underground waste transfer piping for the transfer of radioactive waste. Transfer lines are typically a pipe-within-a-pipe design to provide a secondary safety and environmental protection barrier. Tank waste transfers will be increasing as waste is removed from older single-shell tanks and other waste is staged for upcoming processing and disposal. Underground transfer lines often do not have leak detection capabilities or the aging leak detection systems are subject to rainwater intrusion and component failure resulting in false alarms. A dependable reliable system is needed to ensure prompt leak detection capabilities.



A small length of the AGW-Gold cable used for continuous encasement leak detection.

Current Approach

The Hanford Site has traditionally used leak detectors at low points within the encasement system. The existing encasement leak detection is located where the transfer line enters a pit or diversion box. The encasement drain is left open to allow any accumulation of waste or water in the encasement to drain back to the low points in the diversion box or pit. The pit or diversion box leak detectors sense if there is a transfer line leak originating somewhere within the encasement.

The location of leaks cannot be pinpointed with the baseline leak detection system without extensive investigation, and sometimes they cannot be found. The existing system requires significant maintenance and false alarms from rainwater intrusion or component failures impact the reliability of this important system. A significant amount of time is required for operations, maintenance and engineering to keep these leak detection systems functional.

New Technology

The Replacement Cross-Site Transfer System (RCSTS) continuous line leak detectors, using proven off-the-shelf technology, has a split jacket coaxial cable installed inside the transfer line encasement pipe. A microprocessor-based control panel sends a pulsed signal through the coaxial cable and monitors the return signal at a periodic frequency dependent

Benefits and Features

- ◆ Reliable and repeatable detection performance
- ◆ Off-the-shelf commercially available
- ◆ Low maintenance
- ◆ Intrinsically safe operation
- ◆ Leak location capability

upon the cable's length. If waste or rainwater comes in contact with the split jacket coaxial cable the material provides an electrical pathway. The signal issued by the control panel would then have a shorter return time. This determines the leak's location (a simple comparison function with the known linear leak detector cable length). The sensing of liquid requires less than one minute and the detector's function is predictable and repeatable.

The new Diversion Box (Building 6241-A), Vent Station (Building 6241-V) and the control panel located near B-Plant are the three locations where the control panels are installed. These panels provide alarm signals through the RCSTS Operations Control System. These units provide a shutdown of the cross-site transfer pump upon detection of a leak.

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Fluor Daniel Hanford, Inc., Technology Management
TM-DEP-99-001

TECHNOLOGY DEPLOYMENTS

WASTE MANAGEMENT



FLUOR HANFORD



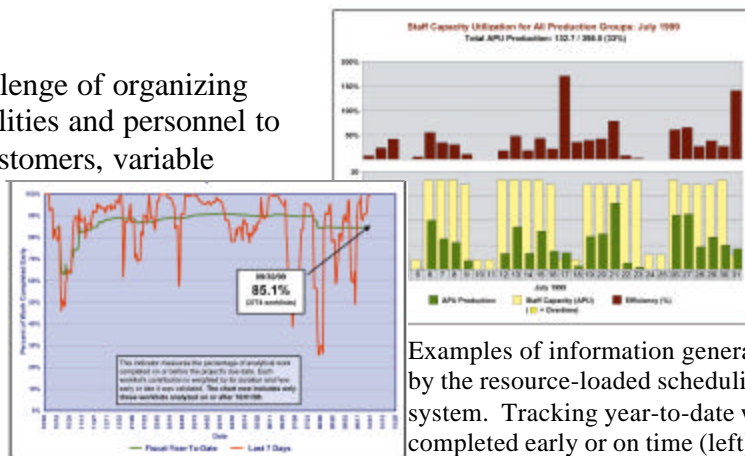


Automated Resource-Loaded Scheduling of Production Activities

The Challenge

Analytical laboratories are faced with the challenge of organizing day-to-day workload to effectively utilize facilities and personnel to meet production commitments for multiple customers, variable product specifications and uneven production flow. This challenge is further complicated by personnel technical qualifications, equipment availability, support personnel, and maintenance and calibration activities.

An example of this type of production environment at Hanford is the Waste Sampling and Characterization Facility (WSCF). This facility provides a wide range of sample processing, chemical analyses, and data reporting for many Hanford customers.



Examples of information generated by the resource-loaded scheduling system. Tracking year-to-date work completed early or on time (left), and staff utilization results (above).

An improved method is needed to organize the day-to-day workload and to plan future work so that personnel and facilities are effectively utilized, backlogs are minimized and, ultimately, the projects are completed early or on time.

Current Approach

Waste Management Laboratory supervision provides general guidance to the analysts at the bench regarding work that “should be performed.” Due dates and sample availability information is available from the Laboratory Information Management System (LIMS) to help organize their work. The analysts make the call regarding what is worked on a given day. The successful completion of a project relies on the attention paid and the influence exerted by project coordinators. The laboratory does not have highly reliable methods for predicting its ability to accommodate proposed work while taking into account its current commitments.

New Technology

A software system providing resource-loaded scheduling of the analytical workload is being adapted for, and implemented at, the Waste Sampling and Characterization Facility. This system was initially developed and implemented at the 222-S Laboratory and has been modified for application at WSCF.

Benefits and Features

- ◆ Systematic and strategic approach to resource tracking and allocation
- ◆ Prescriptive work schedules
- ◆ Progress and performance monitoring tools
- ◆ Predictive tools for planning future work

The foundation for this software is the Microsoft *Office 97* application suite, primarily *Access 97*. Substantial customized code has been added to implement the scheduling algorithm, catalog and track the resources, link with the LIMS, generate status reports and charts, monitor laboratory performance, and distribute the work schedules. The proprietary resource-loading algorithm takes into account individual project due dates, facility status (availability of workstations and maintenance activities), personnel availability (work schedules, days off, training, etc.), personnel qualifications (specific training on analytical methods), and workstation backlogs in the prioritization of the workload and in the assignment of this work to analysts and workstations.

Each day a production schedule, consisting of a task list, is generated for the analytical staff showing the work that should be completed. Daily feedback is obtained and work not completed is returned to the system for reconsideration during the generation of subsequent schedules. This approach provides systematic, logical, and strategic guidance for getting the work done. The process is built into the laboratory's infrastructure rather than being

reliant on the variable behaviors of individual analysts, chemists, and project coordinators. This technology enables the laboratory to quantitatively model the optimum analytical capacity and predict the ability to accommodate future work.

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TECHNOLOGY DEPLOYMENTS

FACILITY STABILIZATION PROJECT



FLUOR HANFORD



B&W Hanford Company
a McDermott company



Power Tool Estimator Used for PFP Integrated Program Management Plan

The Challenge

The Hanford Site has hundreds of facilities and buildings dating from the late 1940's to more recent construction. These facilities will require deactivation and decontamination (D&D) to achieve the site cleanup mission. An early step in the planning process is estimation of the required detailed tasks, resources, and costs to D&D the facilities. This is typically done using historical configuration data combined with field walkdowns. This information has often been difficult to obtain due to the vintage of construction and design media, and the sheer volume of field data to be manually recorded.

One of these facilities is the Plutonium Finishing Plant (PFP). A team of planners and estimators were preparing a major revision to the Integrated Program Management Plan for the PFP. Accurate estimates of the costs and resources to perform D&D of this complex facility were needed. The PFP includes eight non-reactor nuclear facility buildings and hundreds of rooms with a wide variety of internal piping, ductwork, equipment and other features that must be considered when planning D&D activities.



A technician holding the portable computer with estimating software used in the field compares data with the summary tables stored on the standard personal computers in the office.

Current Approach

Past practice for this type of planning effort required manual recording of information about each room or area, using historical records and field walkdowns. The results were subject to transcription errors and, due to the large volume of data, an acceptable level of detail for planning purposes was difficult to attain. An estimator would use the manually recorded data to prepare a list of the tasks needed to clean up the room, and estimate the duration of the work done by the required engineering, planning and craft personnel. Then the estimator could add up the costs and resources to perform D&D of the room, building and facility. These estimates would then need to be rolled up into the overall planning process.

Benefits and Features

- ◆ Accurate estimates obtained in the field
- ◆ Reduces chance for transcription errors
- ◆ More detailed estimates with less manpower
- ◆ Ability to easily adjust cost and scaling factors for recalculations

New Technology

The Power Tool Estimator technology provides a portable computer and software package that is more accurate, easy to use, and requires a smaller field walkdown team compared to manually recorded data. The use of a computer-based system also provides benefits in flexibility for changing rates, assumptions, and methods to roll up and report results.

The Power Tool is a combination of special software designed for on-the-spot estimating tasks, and a versatile handheld computer. The software was developed by B&W Hanford Company (BWHC) Faster Services, BWHC Technology Integration, and Polestar Applied Technologies for the Department of Energy. This application has improved the ability to achieve accurate, efficient estimates for major D&D projects. The software provides a preset form that allows a field estimator to input measured and observed data for the room or equipment being considered for D&D. The software is loaded on a small handheld PC that can also be held at a convenient height for data entry by a neck-strap. After data for a number of rooms and from several field estimators is obtained, the information can be uploaded into a standard desktop PC for rollup and other manipulation.

BWHC obtained several of these Power Tool units for use in D&D task estimates during the preparation of the PFP Integrated Program Management Plan in 1999. Personnel preparing estimates for the plan took the Power Tool units into the facilities and walked through each room, inputting data on the room dimensions, functions, piping, ducting and various equipment. The results were downloaded and rolled up into summary tables on standard personal computers.

The estimates, which were developed using the Power Tool software, proved easy to use in the rollups on standard computers. Through the deployment of this technology, the PFP Integrated Project Management Plan was completed on schedule and will serve as the baseline plan for the D&D of the facility. The Power Tool estimating system is now available for use in similar detailed planning exercises at the Hanford Site.

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TECHNOLOGY DEPLOYMENTS

INFRASTRUCTURE



FLUOR HANFORD

DynCorp
Tri-Cities Services, Inc.



Field Simulator for System Testing and Start-Up (SIMCart™)

The Challenge

The Hanford Site has dozens of operating facilities including waste management, waste treatment, and service utilities such as water and steam supply. Several manual systems at Hanford are being automated, and that conversion brings a new set of challenges associated with system validation and testing. Most systems have field components (e.g. control devices, valves, or pressure transmitters) installed in remote pits, below ground vaults or in radiation zones making access more difficult. Automating existing or new facilities includes programmable logic controllers (PLC) and digital control systems (DCS) in centrally located clean areas and requires installation of tens or even hundreds of field located control devices (input/output modules). Testing and validation of the PLC, DCS and associated I/O modules on the field components are time-consuming as the process requires significant manual labor in the field to ensure all components are properly installed and will function as intended. The ability to effectively test these complex systems is reduced with multiple control strategies, numerous input and output devices, and different controllers and networks. The challenge, therefore, was to deploy a technology that could ensure quality acceptance testing of automated systems in a greatly shortened time frame at a reduced cost and reduced risk to the workers.



The SIMCart is used to test the Hanford Water Control System PLC prior to field installation in the 200 Area.

Current Approach

The current method to test automated PLC-based control systems involves cycling each field device through various operating stages to ensure that correct responses occur for all ranges of input and output signals. Signal values must be pre-established for manual input that will simulate automatic operation. Each device is activated through a suitable operating cycle to provide assurance that temperatures, pressures, levels, and valve positions respond correctly as designed. Test input values for each device are entered and the tester looks for system feedback via installed monitoring test instruments, control devices or graphical interface points. Records are maintained including, the tester's name, date, time, and initial data. This process continues for each device and can involve up to a thousand or more test points depending on system sophistication. Stationing multiple personnel at each device or groups of devices to record data and validate instruments and wiring can consume significant manpower for weeks to complete a system. The problem is that the above methods are labor intensive, do not adequately model the exact field

Benefits and Features

- ◆ Pre-field Testing of PLC/HMI & DCS systems
- ◆ Electronic documentation of test results and exceptions
- ◆ Diagnostic tools to assist in system configuration
- ◆ Repeatable, validated and verified testing
- ◆ Method for simulation and operator certification training

conditions, and are not easily repeatable, especially for present systems that typically require a high degree of validation and verification.

New Technology

SIMCartTM was developed by the Computerized Control and Automation Design (CCAD) team at Fluor Daniel Northwest, providing a novel and cost effective approach to the staging and testing of PLC and DCS systems before delivery to the field. SIMCartTM also provides a very fast and efficient method to test field-wiring connections after installation of the tested system.

SIMCartTM consists of a Programmable Controller connected to a smart Input/Output (I/O) system within the SIMCartTM. The SIMCartTM smart I/O are connected to the target PLC or DCS system to be tested in the field via wiring harnesses. The SIMCartTM is then configured to generate field test cases and record the system responses. SIMCartTM becomes the process to simulate both sensors and control elements. All tests are repeatable and form a quality record suitable for auditing purposes.

Instead of the typical method of single point-by-point testing with multiple personnel, an entire system can be tested simultaneously with a minimum amount of configuration time. Connection of multiple SIMCarts can match any size large or complex field system. Simulator packages are able to perform multi-point testing automatically generating an *actual* real time field signal (e.g. 4 to 20 milliamp), test actual field device signal responses from the installed system, and provide a finished set of test reports formatted for Quality Assurance signoff.

Current point-by-point testing methods require hundreds or even thousands of repetitive manual steps that by their nature propagate mistakes.

SIMCartTM requires an initial configuration of database tables and wire harness connections reducing the actual test period from days or weeks to just hours.

The SIMCartTM has been used successfully on the Saltwell flammable gas qualified exhauster skids for ventilation of high level waste tanks. SIMCartTM ensured that these important systems were thoroughly acceptance-tested before implementation in the field.

The SIMCartTM was also used on the newly installed Hanford Site Water Control System upgrade for the 200 Area. The lead engineer for the project estimates that the SIMCartTM reduced start-up time from a projected 8 to 10 weeks to just eight *days*. SIMCartTM has many applications at Hanford and is currently being marketed off site for widespread use in industry and commercial system installations.

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Fluor Daniel Hanford, Inc., Technology Management
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SIMCartTM is a trademark of Fluor Daniel Corporation

TECHNOLOGY DEPLOYMENTS

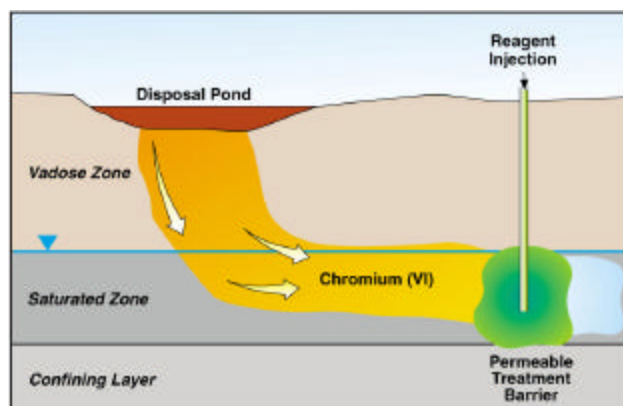
ENVIRONMENTAL RESTORATION



Bechtel Hanford, Inc.
Environmental Restoration Contractor
for the Department of Energy



In Situ Redox Manipulation



SUMMARY

The In Situ Redox Manipulation (ISRM) technology was deployed to treat a hot spot in the chromate plume near the Columbia River in the 100 Area at the Hanford Site.

The ISRM technology creates a permeable treatment zone in the subsurface environment to remediate redox-sensitive contaminants. These redox-sensitive contaminants are immobilized or destroyed as they migrate through the manipulated zone.

The permeable treatment zone is created by reducing the ferric iron in the aquifer sediments to ferrous iron by injecting a reducing reagent and appropriate buffers (e.g., sodium dithionite and potassium carbonate). The ISRM approach is able to remediate contaminants deep in the subsurface by using conventional groundwater wells. The use of groundwater wells allows more flexibility with depth than more conventional permeable reactive barriers that can typically treat only shallow contamination

because they usually require emplacement of a slurry by trenching.

INNOVATIVE TECHNOLOGY DESCRIPTION

The ISRM technology involves creating a permeable subsurface treatment zone to reduce mobile chromium in groundwater to an insoluble form. This is accomplished through the injection of sodium dithionite into the aquifer through a series of wells. Several days after injection of the sodium dithionite, unreacted reagent and reaction products are removed from the aquifer by extracting groundwater from the injection wells. The sodium dithionite reduces ferric iron to ferrous iron within the aquifer sediments, producing a reducing environment. Under these conditions, hexavalent chromium precipitates from the plume as non-toxic, less-mobile trivalent chromium.

BASELINE DESCRIPTION

Pump-and-treat technology is the present selected remedy identified for remediating chromium-contaminated groundwater. The goal of the pump-and-treat technology is to reduce chromium concentrations in groundwater to the maximum extent possible using injection and extraction wells. The ISRM technology provides a cost-effective treatment alternative.

DEPLOYMENT DESCRIPTION

The ISRM technology is currently being deployed at a chromate (hexavalent chromium) plume in the 100

Area near the Columbia River at the Hanford Site. After successful bench-scale tests, a proof-of-principle field experiment was successfully conducted in September 1995 to determine the feasibility in creating and the projected longevity of a reduced zone in an aquifer at a depth of 25.9 m (85 ft). Three years of monitoring data showed that the treatment zone remained anoxic, chromium levels decreased below the detection limit, and no significant permeability changes were detected.

A larger treatability test was installed in fiscal year 1998 to create a permeable reactive barrier 45.7 m (150 ft) long and 15.2 m (50 ft) wide using five wells. Recent monitoring data have shown that chromate concentrations in the reduced zone have decreased to levels below detection limits and chromate concentrations are decreasing in several downgradient monitoring wells. The treatability test also showed that the treatment barrier does not impede groundwater flow.

Based on the success of the treatability test, the reactive barrier will be expanded to approximately 213.4 m (700 ft) in length between late fiscal year 1999 and fiscal year 2001. A series of injection wells will be installed to form the expanded permeable barrier

and thereby intercept hexavalent chromium-contaminated groundwater before it reaches the Columbia River.

DETAILS OF BENEFITS

Installation and operation of the ISRM barrier is relatively inexpensive compared to the baseline pump-and-treat alternative. Operation of the barrier is relatively inexpensive because, after emplacement, external energy sources, management of large volumes of water, or management of secondary waste is not required.

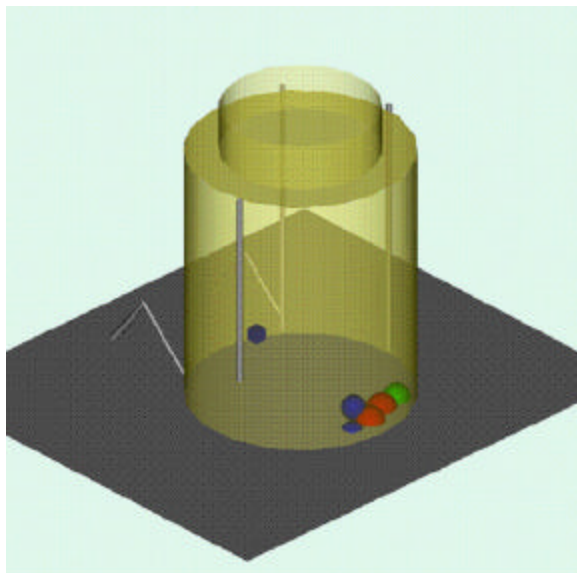
The ISRM process provides a permanent in situ solution for groundwater remediation. Once treated, the contaminant becomes less toxic and remains immobilized. Risk is also reduced through a reduction in human exposure to waste products. The barrier is renewable and can be re-established, if needed, during the length of the project.

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3-D Visual and Gamma Ray Imaging System



SUMMARY

The 3-D Visual and Gamma Ray Imaging System can remotely survey large areas and individual objects for gamma-ray emissions and display the results as combined three-dimensional (3-D) representations of the radiation sources and the equipment.

The technology was deployed at the 221-U Facility for characterization of equipment within the processing cells of the facility. This information was gathered in support of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

INNOVATIVE TECHNOLOGY DESCRIPTION

The 3-D Visual and Gamma Ray Imaging System consists of four modules: a sensor head, a portable PC compatible computer, a pan and tilt controller, and a 3-D workstation. The sensor head incorporates a coded aperture gamma-ray imaging detector, a high-resolution

video camera, a laser range finder, and a pan and tilt assembly. The sensor head is controlled remotely by the PC and the pan and tilt controller. The laser range finder and the ability to resolve angles in multiple axes of motion provides information necessary to triangulate for determination of the actual point in space of the imaging target and the gamma detector. Remote operation and control of the sensor head allows for safe image acquisition in high radiation environments, minimizing operator exposure. During image taking operation, a pseudo-color image of gamma-ray-emitting sources is overlain on the video picture of the scene. At each camera location with observed gamma-ray emissions, additional images are taken of key reference features in the scene, along with the measured range and pan and tilt directions for these features. The later images are used to locate the relative camera positions.

The exposure time required to obtain a gamma image is dependent upon several factors, including gamma-ray energy, the distance to the source, and the shape and distribution of the source. From the two-dimensional (2-D) data the dose estimates at the sensor head are calculated. After 3-D processing, the distance to the source obtained by triangulation is used to derive a dose for the source. The system can calculate a dose at any point in space with a default of a "30-cm" dose rate. The 3-D geometry increases the knowledge of the source location and resulting dose estimate.

A table of source locations and "30-cm" dose estimates is generated for each contaminated object. These data are merged with a drawing generated in AutoCAD™ for a visual representation of the object. The resulting merged drawing gives source positions with respect to visually identified objects. The merged drawing can be manipulated to allow the representations to be viewed from different aspect angles.

BASELINE DESCRIPTION

The baseline technology is standard manual surveys performed by trained health physics technicians or 2-D gamma imaging. Manual surveys are time consuming, tedious, and directly expose personnel to radiation. Manual surveys provide only quantifiable results from specific locations, but do not necessarily identify the source locations. 2-D gamma imaging does not include range finding and triangulation components needed to resolve the exact location of radiation sources.

DEPLOYMENT DESCRIPTION

The 3-D Visual and Gamma Ray Imaging System was used to survey a portion of the 221-U Facility and provide visual and radiation measurements of contaminated equipment located within the facility. The GAMMAMODELER™ system software was used to transform extended sources into a series of point sources, locate in three dimensions the positions of these sources, and calculate the dose rates for these sources.

The system performed well during the demonstration and obtained data on 21 objects of interest to the CDI Project. Real-time display of the gamma ray images to the operator showed that seven of these objects had detectable emissions. For these objects, additional views were obtained to allow 3-D rendering. The 3-D rendering showed the sources in relationship to the visual object.

Several of the 221-U Facility cells were imaged. Even with the limited viewing angles that could be obtained for these cases, the 3-D rendering software still allowed 3-D representations of the source locations and strengths to be determined. For cell 10, the system was able to determine the source distributions and intensities at distances greater than 12.2 m (40 ft). These sources are of high dose intensities and would not be accessible to health physics technicians using hand-held instrumentation.

Deployment of the 3-D Visual and Gamma Ray Imaging System was accomplished through the support of the Deactivation and Decommissioning Focus Area, which is managed by the Federal Energy Technology Center.

This work was conducted as part of the 221-U Facility characterization in support of the CDI Project. Characterization information is being obtained to support a Record of Decision for the 221-U Facility. The Record of Decision will establish regulatory and technical precedence for future disposition of the other chemical processing facilities (canyons).

DETAILS OF BENEFITS

The system can be positioned outside the radiation area, thus reducing worker exposure and eliminating extensive shielding. This benefit is more pronounced in high radiation areas. Use of the system can provide information on planning a decontamination process that minimizes worker exposure. Compared to the baseline technology, use of the system leads to reduced labor costs, more reliable data, and significantly less radiation exposure.

Operation of the system is relatively simple, but some training is required to ensure that relevant data are obtained. Currently, the use of the 3-D rendering software requires considerable experience in modeling the source distributions.

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AutoCAD is a registered tradename of Autodesk.
GAMMAMODELER is a trademark of AIL.



Quantrad Scout Gamma Spectroscopy System



SUMMARY

The Quantrad Scout system is a lightweight, comprehensive, portable gamma-ray spectroscopy system. It provides gross and spectral gamma radiation characterization data. Survey of the ventilation tunnel at the Hanford Site's 221-U Facility using the Quantrad Scout sensors was accomplished as part of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

The sensors were deployed as part of the initial characterization of the ventilation tunnel in the 221-U Facility. No human access has been allowed in this tunnel since construction, nearly 50 years ago.

The objective of the sensor deployment was to provide data from multiple areas of the tunnel to supplement the limited number of smear samples collected during the characterization effort.

INNOVATIVE TECHNOLOGY DESCRIPTION

The Quantrad Scout system consists of three parts: the Scout base, a palmtop computer, and a probe. The Scout base includes a 512-channel Multi-Channel Analyzer (MCA), a high voltage power supply, and memory circuitry for storing spectra. The palmtop computer provides an interface to the Scout MCA unit. A number of different probes can be used with the Scout base. The system is small and durable and can operate using a transformer or a 12-volt battery.

Measurement of high- and low-energy gamma emissions was accomplished using two separate Scout sensors. One Scout unit included a low-energy optimized detector; the other unit included a high-energy optimized detector. The units were calibrated and configured to perform repeated 3-minute counts until the memory was full, the power dropped below a set value, or the instruments were manually shut off.

The Scout system, while commercially available, is usually deployed in a manually operated mode for specific analysis. The 221-U Facility deployment used the Scout system in a different configuration in conjunction with a robot deployment platform.

BASELINE DESCRIPTION

Prior to this deployment, the physical and radiological conditions of the ventilation tunnel were unknown and, as such, personnel access was prohibited. This remote sensor characterization

system was considered an enabling technology. Previously, robot remote characterization platforms have been used to collect smear samples during characterization in other areas where personnel access was prohibited.

DEPLOYMENT DESCRIPTION

The initial characterization of the ventilation tunnel in the 221-U Facility was completed in September 1999. Scout sensors were placed in steel boxes with “ports” for radiation measurement and wrapped for contamination protection. The boxes included batteries sufficient for 30 hours of operation, much longer than the planned deployment. Each unit was in an individual box. The units were transported

into the tunnel using a robot deployment platform (the Andros robot) and collected spectra over the desired time period.

DETAILS OF BENEFITS

Use of the Scout sensors provides a means for gamma spectroscopy in remote locations and delivery by robot deployment platforms. Thus, enhanced radiological characterization data may be obtained for locations where personnel access is prohibited.

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Alpha Sentry Continuous Air Monitor



SUMMARY

The Alpha Sentry Continuous Air Monitor (Alpha Sentry CAM) provides a means for workspace monitoring in plutonium-contaminated areas. A patented diffusion screen removes 95% of the unattached radon daughters from the air sample. A spectroscopic algorithm effectively subtracts the radon daughter interference from the transuranic region of interest. The Alpha Sentry CAM system is able to monitor up to eight sampling locations from a single operator interface.

Alpha Sentry CAM systems were phased into use at the 233-S Facility between March and July 1999.

INNOVATIVE TECHNOLOGY DESCRIPTION

The Alpha Sentry CAM is a multi-channel continuous air monitor for alpha contamination. Several features of this system enhance detection and warning capabilities in an alpha environment:

- The system design removes attached radon from the air stream, which effectively eliminates 95+% of the background normally seen on alpha CAM systems. This increases the reliability of the system, eliminating false alarms due to fluctuating radon levels.
- The solid-state alpha spectrometer used as the detector in the system allows the user to customize the system settings based on the alpha-emitting isotopes of interest in the facility.
- The introduction of a system controller that allows remote monitoring of up to eight air monitoring heads at once increases the warning capabilities of the system. The controller provides real-time air monitoring capabilities of work areas. Airborne levels can be checked before entering the work space.
- The controller readout can be set to provide airborne contamination levels in derived air concentration (DAC) or DAC-hr, eliminating computations by workers.

BASELINE DESCRIPTION

The baseline technique for downposting an area for alpha contamination was to collect air samples that had to be decayed for up to 72 hours before a definitive determination of the airborne contamination levels could be made.

DEPLOYMENT DESCRIPTION

The Alpha Sentry CAM was deployed at the 233-S Facility as part of decommissioning efforts. The system was phased into use in multiple locations between March and July 1999.

DETAILS OF BENEFITS

Since deployment, it is estimated that the system has paid for itself by eliminating the need to delay downposting of areas. In the past, air samples collected for this purpose have had to be

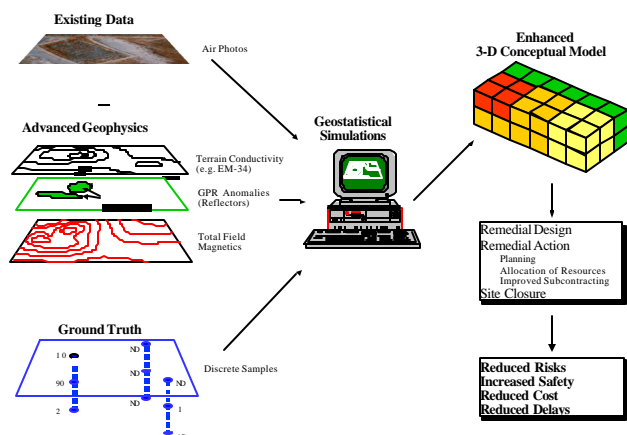
decayed for up to 72 hours before a definitive determination of the airborne contamination levels could be made. Due to the radon discrimination capabilities of the Alpha Sentry CAMs, downposting determinations can be made instantaneously, because the system is constantly monitoring the airborne levels of the isotope of interest.

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Enhanced Site Characterization System (ESCS)



geophysical, chemical, and radiological survey techniques to produce detailed maps of the subsurface.

Examples of advanced geophysical methods include:

- Electromagnetic offset logging
- Induced polarization
- Cs-vapor magnetometer
- Time-domain electromagnetics.

Data from these advanced methods complement existing data sets from traditional methods, which include the following:

- Historical records and photographs
- Conventional geophysical surveys
- Soil gas surveys
- Radiation surveys
- Trench and borehole sampling.

SUMMARY

The Enhanced Site Characterization System (ESCS) combines advanced geophysical data and interpretation techniques with existing information, traditional characterization, and “ground truth” data for type matching of geophysical and chemical signatures to various waste types. The system uses geostatistics to integrate multiple data sets and produce a more detailed map of the subsurface contents than is possible using individual characterization technologies.

Deployment of the ESCS was initiated in February 1999 to characterize an unexcavated portion of the 618-4 Burial Ground.

INNOVATIVE TECHNOLOGY DESCRIPTION

ESCS is an advanced characterization system that can utilize information from a variety of

Geostatistical techniques are used to integrate the multiple data sets to model the spatial distribution of the data and provide estimates of uncertainty. The integration is accomplished using a combination of multivariate statistics and geostatistical conditional simulations, and closes the data gaps normally found when each data type is interpreted separately. The product of the system is an integrated three-dimensional conceptual model of the distribution of various waste types in a burial ground. This model can be used for planning future excavation at the site; reducing economic, health, and safety risks during excavation; and reducing remediation costs.

BASELINE DESCRIPTION

The baseline characterization includes review of historical documents and aerial photographs, performance of conventional surface geophysics and soil gas surveys on a limited basis, and collection of soil and waste samples from boreholes or trenches.

DEPLOYMENT DESCRIPTION

The ESCS was deployed to characterize an unexcavated portion of the 618-4 Burial Ground. Excavation in the burial ground was halted upon discovery and partial excavation of a cache of drums containing depleted uranium waste. Additional characterization of the remaining area of the burial ground was needed to plan for continued excavation in the area of the drummed waste.

All previous geophysical and sampling data for the 618-4 Burial Ground, as well as “ground truth” data from the excavated portions of the burial ground, were compiled and processed to produce an initial integrated set of pre-excavation maps for the burial ground. These initial pre-excavation maps were completed on April 15, 1999. Interim results from this activity found that the available geophysical data and ground truth data were of poor resolution and would not support precise location and volume definition of a targeted cache of drums discovered in the burial ground, nor would these data support accurate spatial correlations.

Acquisition of supplemental geophysical (electromagnetic offset logging [EOL]) data targeted at the cache of drums was initiated in May 1999. Access boreholes were installed for

collecting samples and EOL data. Geophysical data acquisition was conducted in early to mid-June. A specialized resistivity cell was developed to measure the resistivity of the soils and its relationship to soil moisture. These data provide background soil resistivity data that help improve the geophysical analysis of the EOL data.

Existing ground penetrating radar and magnetic data were reprocessed/reinterpreted to develop geostatistical correlograms for these data sets. Geostatistical simulations and preparation of the pre-excavation map of the 618-4 Burial Ground were completed in September 1999.

DETAILS OF BENEFITS

The ESCS is capable of delineating waste boundaries and locating various categories of wastes, including high-risk wastes. This system is an improvement over the current baseline practice in that it can support excavation planning and waste handling decisions. Thus, the technology helps reduce the risk of costly delays and inappropriate mobilization of remedial resources, improves remedial alternative selection and design, and enhances pre-planning and prioritization of equipment and resources needed for remedial actions.

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Non-Intrusive Liquid Level Detection Technology



SUMMARY

Non-Intrusive Liquid Level Detection technology (NLLDT) uses infrared thermography to assay tanks and equipment for the presence of liquids. As such, liquid level information in tanks or equipment can be obtained for use in planning decommissioning activities.

The canyon deck of the 221-U Facility contains numerous vessels and equipment. The NLLDT System was deployed to assay selected equipment for the presence of liquid. This information was gathered in support of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

INNOVATIVE TECHNOLOGY DESCRIPTION

Non-intrusive liquid level detection technology is the use of infrared thermography coupled with either normal ambient temperature changes or local, low-level heating or cooling to passively and non-intrusively detect liquids in tanks and piping. Specifically, infrared imaging cameras are used along with specialized testing procedures to exploit physical property variations in the tanks/pipes and contained liquid and air to produce temperature contours of images that identify the liquid levels. Infrared thermography is the process of converting heat emitted from an object into a visible dynamic television-like picture.

The technology provides a non-intrusive method that can determine presence/absence of liquids in congested facility equipment.

BASELINE DESCRIPTION

Visual inspection, boroscopic visual inspection, and dipsticks are the baseline technologies for determining the presence or absence of freestanding liquids in facility equipment. Liquid detection in pipes is accomplished by finding low points and tapping the pipe for inserting sampling parts.

DEPLOYMENT DESCRIPTION

The NLLDT was deployed to detect liquids in a number of selected targets. Ten target vessels and a

number of piping assemblies located on the canyon deck of the 221-U Facility were selected for assay.

The deployment factors included the following:

- Capability to detect liquids in vessels and piping assemblies
- Capability to operate in a radiologically contaminated environment and to perform the demonstrations in such a way as to avoid contamination
- Ability to easily decontaminate equipment with conventional practices
- Capability of the computer and software for liquid level analysis.

Infrared and visual cameras were positioned to capture timed sequences of approximately 30 images per target. When required, external heat was applied to force temperature gradients. Images were analyzed using computer software to characterize the tanks or piping assemblies.

Deployment of the NLLDT was accomplished through the support of the Deactivation and Decommissioning Focus Area, which is managed by the Federal Energy Technology Center. This work was conducted as part of the 221-U Facility characterization in support of the CDI Project. Characterization information is being obtained to support a Record of Decision

for the 221-U Facility. The Record of Decision will establish regulatory and technical precedence for future disposition of the other chemical processing facilities (canyons).

DETAILS OF BENEFITS

The use of the NLLDT System to detect liquids in vessels and pipes eliminates the need to physically open and inspect these vessels. Risks to workers associated with gaining access to these types of objects and the possible exposure to radioactive or contaminated materials can nearly be eliminated.

Benefits measured in the deployment at the 221-U Facility are shown below.

| Feature | NLLDT System | Baseline |
|--------------------|--------------|-----------|
| Average setup time | 30 minutes | 7.9 hours |
| Inspection time | 30 minutes | 24 hours |
| Cost/tank | \$600 | \$3,600 |

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Hand-Held Exploranium GR-130 miniSPEC Instrument



SUMMARY

The Exploranium GR-130 miniSPEC is a hand-held instrument that can collect both gross gamma-ray and spectral information. A major application intended for the GR-130 instrument is to field scan soils contaminated with liquid effluent that originated from reactors. These soils must be evaluated to below the waste acceptance levels (which are in the low pCi/g activity ranges) to determine environmental restoration disposal requirements. The radioisotope contaminants are predominantly cobalt-60, cesium-137, europium-152, and europium-154. The desire is to detect and semi-quantify the levels of these isotopes in soils having differing soil matrices.

The instrument was deployed to segregate soils for waste minimization during pipeline remediation at the 100-D Area of the Hanford Site.

INNOVATIVE TECHNOLOGY DESCRIPTION

The GR-130 instrument is capable of operating in the following modes:

- Survey mode
- Dose rate mode
- Radionuclide identification mode.

In the survey mode, the instrument displays a total spectrum count per second. This mode is useful when a known path is traversed in a fixed time period. In the dose rate mode, the instrument can act as a sensitive $\mu\text{R/hr}$ meter for scanning soils and materials. In the radionuclide identification mode, the GR-130 identifies individual gamma-ray-emitting radionuclides, which is useful when these isotopes are the principal concerns in monitoring or remediation operations.

BASELINE DESCRIPTION

The baseline method for radiological screening uses a 5-cm by 5-cm (2-in. by 2-in.) sodium iodide detector connected to a rate meter. The rate meters used can display a count rate and an accumulation rate. This instrument is sensitive and responds well to low-level gamma activity but cannot be used for soil characterization; samples need to be sent to a laboratory for analysis. Exposure rate information must be collected using different hand-held

instruments. Therefore, the baseline requires two instruments plus laboratory analysis to provide the same information that can be obtained with the GR-130.

DEPLOYMENT DESCRIPTION

The instrument was tested to determine its directional sensitivity using a series of isotopes, and the efficiency of the instrument was calculated using these data. The GR-130 demonstrated some gamma-ray sensitivity in the mid-energy range. The sensitivity to high-energy gamma rays is low, as is expected with a sodium iodide detector. The Compton effect masks the lower energy gamma rays; energies below 350 keV were neither apparent in the spectrum nor detectable by the peak search routines.

A field test of the instrument was conducted at a contaminated soil site on the Hanford Site. A hot spot was determined using the dose rate mode; a maximum dose rate of 40 $\mu\text{R/hr}$ was measured. The hot spot was determined to be approximately 1.5 m (5 ft) in diameter, with contamination being more diffuse away from the center. The instrument was placed in the center of contamination and left to acquire a 1200-second live time count. Following the count, two soil samples were collected and analyzed. The data were used to calculate counting time necessary to detect the analytes of interest near the cleanup levels.

Following successful testing, the instrument was deployed to segregate soils for waste minimization during pipeline remediation in the 100-D Area of the Hanford Site. The instrument was used to identify hot spots to aid remediation operations and enable more effective selection of locations for verification samples.

DETAILS OF BENEFITS

The benefit to the user is a real-time analysis of isotopes present. Working with unknown sources of radioactivity is the business of remedial action and decommissioning activities. Usually, this information is only available by taking samples, transporting them to a laboratory, and waiting for the results. Laboratory turnaround time can be as long as two weeks. In the interim, the project is left with proceeding at risk or with assuming unnecessary and expensive precautions rather than wait for laboratory results. Additionally, sampling requires that only a small portion of the area or material at risk be analyzed, and it is then hoped the samples are representative of all the material to be encountered. The GR-130 not only provides real-time data, but can also sample a comparatively large number of samples for a minimal cost.

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TECHNOLOGY DEMONSTRATIONS

TABLE OF CONTENTS

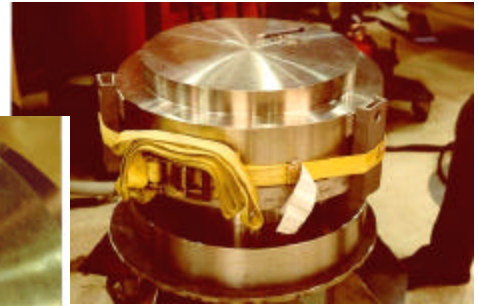
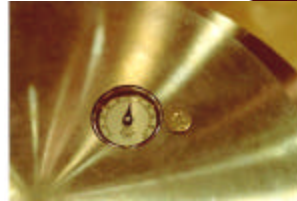
| | |
|---|----|
| Multi-Canister Overpack Magnetically Coupled Pressure Monitor..... | 61 |
| Personal Ice Cooling System (PICS)..... | 63 |
| On-Screen Electronic Routing Board..... | 65 |
| Soil Sampling and Soil Characterization Probes | 67 |
| Cone Permeameter..... | 69 |
| Laser Ablator for Decontamination of Metal Surfaces | 71 |
| Simulation of the Stabilization Processing at the Plutonium Finishing Plant (PFP).... | 73 |
| Laser Cutting of Cell Liners..... | 75 |
| PFP Glove Port Monitor..... | 77 |
| In Situ Vitrification..... | 79 |
| Staveley Ultrasonic Liquid-Level Detection Technology..... | 81 |
| Non-Intrusive Liquid-Level Detection Technology..... | 83 |
| Sonic Cone Penetrometer..... | 85 |



MCO Magnetically Coupled Pressure Monitor

The Challenge

The large quantity of uranium metal fuel from the Hanford N Reactor is stored in the two water-filled K Basins. The Hanford Spent Nuclear Fuel (SNF) Project is charged with moving the fuel from the current location in close proximity to the Columbia River to interim dry storage. To accomplish this, the fuel will be vacuum-dried and stored in 400 large new canisters called Multi-Canister Overpacks (MCOs). The MCOs in turn will be placed in storage tubes at Hanford's Canister Storage Building. The fuel is quite old and often in a damaged condition. The damage can result in bare uranium being exposed to residual water remaining in the MCOs after drying. As the water reacts with the uranium fuel, hydrogen gas will be generated with the potential to pressurize the canister to some extent.



Multi canister overpack cap. Inset – cap with pressure indicator recessed in the top. A magnet located 8 inches below the needle rotates in response to internal pressure changes.

The safety of a Multi-Canister Overpack is established by calculations showing that pressure limits of the vessel will not be exceeded but “defense in depth” drives the desire for confirmatory information. Data reflecting the pressurization of the MCOs will also be used to make judgments with respect to the eventual shipment of the N reactor fuel to a geologic repository. The need to vent the MCOs prior to shipment or the ability to ship without further processing will depend in part on the buildup of gas within these canisters.

The challenge is to monitor this pressure increase over decades of dry storage time in a manner which does not result in labor intensive handling of the MCOs with resulting personnel radiation exposure. The introduction of a monitoring device also should not result in any additional penetration of the MCO pressure boundary.

Current Approach

Under the current plan, a maximum of 6 MCOs will be extensively instrumented for 2 years to understand the trend of gas accumulation. A sample of gas will also be collected from these few MCOs but no more frequently than quarterly. The remainder of the MCOs would have no monitoring without the technology currently demonstrated.

New Technology

The monitoring device of choice should measure pressure on the inside of the MCO and transmit that information to an easily read

Benefits and Features

- ◆ Indicates internal pressure with no intrusion into the fuel canister
- ◆ Senses pressure build-ups of up to 600 psi
- ◆ Fits into existing process ports with no design change

device on the outside. The approach taken here is to mount a Bourdon gauge in one of four process ports that penetrate a stainless steel MCO shield plug. The shield plug is the top fixture welded to the cylindrical canister of fuel. A magnet is attached, through a series of miniature gears, to the gauge such that an increase in pressure results in a rotation of the magnet. The entire gauge/magnet assembly is covered with a welded plate that completely closes the process port and isolates the MCO interior. Normally a cap is welded over the shield plug and it is on this cap that a compass-like magnetized needle gauge is mounted. This needle senses the rotation of the internal magnet in the shield plug, rotates in tandem with the magnet, and provides an indication of internal pressure.

Demonstration Description

A prototypic stainless steel MCO shield plug and cap were used for the demonstration to keep dimensions and materials the same as in a future deployed version. The gauge/magnet assembly was mounted in a process port and the needle gauge mounted on the cap. Configurations corresponding to full-scale indications of both 100 and 600 psi were tested. Pressure on the MCO interior side was maintained with Argon gas and monitored with a second calibrated pressure gauge. The primary goal of the demonstration was to demonstrate that the new magnetically coupled pressure gauge on the exterior of the MCO cap read within 10 percent of the reading given on the interior side. Secondary goals were to demonstrate that the magnet did not affect plasma arc welding on an MCO and that a canister storage building storage tube (simulated by a low carbon steel cylinder) did not affect that performance of the needle/magnet coupling.

Demonstration Results

Comparison of the applied and measured pressure showed that both accuracy and precision of the new gauge were within 3 to 4 percent in both the 100 and 600 psi demonstrations. The storage tube surrounding the MCO did not affect the measurements. The presence of the magnet associated with the new gauge did not perturb welding of the shield plug to a simulated MCO shell. The demonstration has resulted in a decision to procure 10 units early in FY 2000 for engineering evaluation expected to lead to deployment in FY 2001.

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Personal Ice Cooling System (PICS)

The Challenge

The Hanford Site is located in a semi arid region of Washington State where summer temperatures can exceed 100 degrees F. Many of the operations, maintenance, upgrade and remediation tasks are situated outdoors where various types and layers of anti-contamination clothing are required. Such personnel protective equipment (PPE) protects the workers from contamination, but can significantly compromise the body's ability to cool itself. For this reason, controlling heat stress is important from a project management perspective because shortened stay-times can also lead to a delay in the completion of field activities. Heat stress control is also of paramount importance from a health and safety perspective because of the seriousness of heat stress-related illnesses. The challenge is to minimize heat stress while providing optimum worker comfort, protection and greater stay-time in the field.



Example of PICS vest, shirt, pant and hood undergarments. Chilled water and pump pack are worn around the waist.

Current Approach

Current methods for protecting workers from unacceptable temperature extremes during the hot summer months include limiting the time spent in radiation zones, providing extended and extra work breaks, beverage supplements and wearing hoods with supplied conditioned air via umbilical tubes. These methods each have limitations and are less than ideal (i.e., they don't last long enough, are awkward, inefficient or require a combination of methods to satisfy worker protection). The current heat stress program at Hanford also employs physiological monitoring and use of air-conditioned cool down rooms where available.

New Technology

The Personal Ice Cooling System (PICS) is a self-contained, core-body-temperature control system that uses ordinary ice as a coolant and circulates cool water through tubing that is incorporated into durable and comfortable, full-body garments (e.g., pants, shirts, vests and hoods). Water is frozen in bottles that are worn outside or inside of PPE clothing in a sealed, insulated bag, with a circulating pump attached to a support harness system. The use of a rate-adjustable, battery-powered pump circulates the chilled water through the small diameter tubes sewn into the garments. The adjustable pump allows

Benefits and Features

- ◆ Ensures safer body temperatures
- ◆ Increases worker well-being, comfort and productivity
- ◆ Increases stay-times, thus reducing cost and accelerating schedules

the worker to control his temperature based on the environment and his workload. The combined weight of the ice bottle, pump and suit is only about twelve pounds. The torso portion of the suit can be worn with a hood and pants, depending on the amount of cooling needed. The garment is worn under the first layer of PPE and is considered personal clothing – it can be laundered normally.

Demonstration Description

During late spring of 1999, about ten PICS suits were provided to the Hanford Site as part of a promotion sponsored by the vendor and DOE's Office of Science and Technology (EM-50). The vendor and an experienced "user" and contract employee from Fluor Daniel Fernald also visited Hanford to provide briefings on the benefits and proper use of the PICS. The briefings were attended by safety representatives from most of the Hanford contractors. During the high temperature months of July, August and September 1999, a number of field tasks were selected for trial application of the PICS. Most trials were in support of field activities within or near Hanford's tank farms (e.g., SX Tank Farm borehole drilling, hot water additions for waste tank flushing, etc.). While a formal report was not issued on the specific results of the field activities at Hanford, feedback on the field trials was relayed through project safety organization representatives.

Demonstration Results

The general feedback received from the field operations staff indicated that the vests did

indeed provide additional comfort, and that workers were able to perform scheduled work activities for longer periods before needing rest. On nearly all jobs, the ice in an individual bottle lasted between 1-2 hours.

A controlled and detailed comparison of the PICS versus baseline heat stress management techniques is documented in "Innovative Technology Summary Report – Personal Ice Cooling System (PICS), DOE/EM-0393," which can be accessed via website <http://OST.em.doe.gov> under "Publications."

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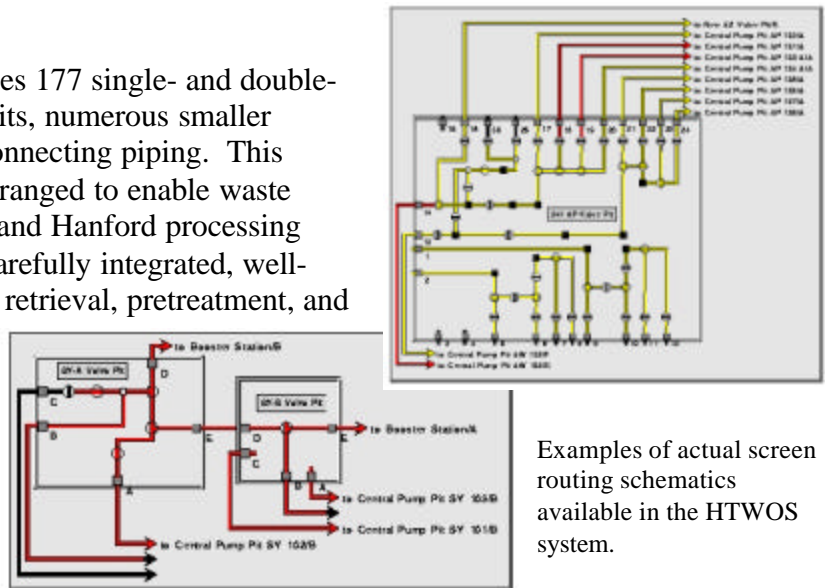
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TM-DEM-99-009



On-Screen Electronic Routing Board

The Challenge

The River Protection Project (RPP) includes 177 single- and double-shell waste tanks, several hundred valve pits, numerous smaller receiver tanks and 50-plus miles of interconnecting piping. This complex piping infrastructure system is arranged to enable waste transfers to and from virtually every tank and Hanford processing facility. The cleanup mission requires a carefully integrated, well-planned sequence of waste feed routes for retrieval, pretreatment, and blending of waste. Various contingency routes also are needed to accommodate possible equipment failures, solids settling or transfer line plugging. There are many common pipe branches used as a partial path for the completion of transfer routes. If one valve is positioned incorrectly, the route will not connect to the desired location. To minimize the possibility of misroutings in this complex piping network, a method of maintaining and showing current valve positions in pump and valve pits is needed.



Examples of actual screen routing schematics available in the HTWOS system.

Current Approach

The traditional method of maintaining current tank routing configurations employs a wall size schematic routing board showing a diagram of all possible routes between tanks. The routing board is kept up-to-date by manually marking routes as they are approved and used. The possibility of routes being used but not correctly illustrated on the routing board are high, and because of the complexity of the actual piping and valving, it is impossible to accurately display all routing information on these routing boards.

New Technology

The Hanford Tank Waste Operations Simulator (HTWOS) is a computer simulator for tank farm operational planning based on initial tank inventories and other operations parameters. The HTWOS models the interaction of all major tank farm activities including 1) operational waste movements to include saltwell pumping activities, 2) low- and high-level feed staging, and 3) privatization phase I and II tank farm activities.

Benefits and Features

- ◆ Consistently centrally-located real-time database of current route configurations
- ◆ Positive control of route changes
- ◆ Minimized chance of misroutings
- ◆ Automatic configuration control with the best basis tank inventory

By using a single simulation system to model these activities, interaction of each activity on the other activities is automatically compared to ensure consistency of each operating scenario. Part of HTWOS modeling assumptions includes all tank routes, pump pits, valve pits, and individual valves within the pits. These pump and valve pits, graphically shown on the computer screen, can be interactively displayed.

During this interaction, the lines connecting the valves are shaded to show the path that the pipe contents would take based upon the selected valve positions. This new subroutine modeling feature within HTWOS can be used for real-time electronic tank routing, preserving the current existing routing configuration for all tank farm activities.

HTWOS is an ideal software package for application as a real-time electronic routing board simulator. It can run on a centrally located computer and personnel requiring routing board information can access this centrally running HTWOS from their PC. Users are allowed read-only access displaying the current routing information allowing the user to see the current routing configuration without being able to alter valve positions. Change access would allow the user to modify valve positions creating new tank connecting routes. By accessing the one centrally operated HTWOS, the routing database is always maintained under constant configuration control. Only personnel authorized to make routing changes could, and personnel with read-only privileges could see the current routing configuration and are assured that it really is the current routing configuration.

Demonstration Description

A series of demonstrations were given to several groups within RPP. These groups are responsible for setting up and maintaining routing board configurations until March 1999. The demonstrations showed how the tank routing

feature within HTWOS could be used to maintain a consistent real-time database of the current tank routing configuration. The demonstration also revealed how new routes could be displayed by graphically opening and closing valves on pump and valve pit diagrams on the screen.

Demonstration Results

The ability to maintain a consistent real-time database for tank routing information as well as the ability to conveniently access this information from a personal computer was acknowledged by most groups shown the demonstration as a necessary feature to minimize the risk of misrouting. Current tank farm activities are not sufficiently active at this time to justify an electronic routing system, but it was agreed that for upcoming support of feed delivery operations to private vendors this feature will be a necessary and valuable tool.

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Fluor Daniel Hanford, Inc., Technology Management
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Soil Sampling and Soil Characterization Probes

The Challenge

More than half of the 149 single-shell tanks (SSTs) in the Hanford Site tank farms have been declared "assumed leakers." The vadose zone and soils around the SSTs are known to contain contaminants that have leaked from the tanks and entered the soil column. More up-to-date and extensive data is required to accurately determine the location and extent of existing leakage. The above ground and subsurface layout of the tank farms is not conducive to ideal placement of soil investigation tools such as boreholes. Budget and logistical constraints also limit the number of wells that can be constructed. An efficient, lower-cost and less-intrusive method for soil investigation is needed to support ongoing and future retrieval and site cleanup decisions.



Cone penetrometer platform in position at the Hanford 200 East Area site during demonstration testing. The inset shows the soil sampler components (main pipe (top) and canister (bottom)).

Current Approach

Subsurface contamination in the soils surrounding the SSTs is currently monitored by lowering instruments into existing steel-cased boreholes. The boreholes are spaced around the tanks and extend to varying depths. Gamma detectors are lowered into the boreholes and respond to contamination within a 12-18" radius of the center of the borehole. Leak detection and monitoring effectiveness depends on whether the contamination moves within range of the gamma detectors. Instrument readings from the boreholes are reviewed to determine change in the depth and extent of contamination in the vicinity of the borehole. Data from one borehole to another is extrapolated to produce an approximation of potential leak plume shape and volume. Actual soil sampling cannot be conducted with the existing boreholes. Soil sampling can only occur during the placement of the wells. When wells are drilled with the specific purpose of obtaining soil samples, they are expensive, produce a large amount of soil waste, are located based upon modeling assumptions using past data, and are constrained from moving to many positions/locations around the tank or where data is needed. Most of the existing boreholes were installed prior to 1980. Very few new boreholes or wells have been prepared since, primarily because of regulatory/permitting requirements and funding constraints.

New Technology

Small diameter (less than 2 inches) probes, which use a cone penetrometer (CP) as a delivery system and can be hydraulically pushed into the soil, contain a variety of characterization/detection instruments including gamma and X-Ray fluorescence (XRF) detectors, soil sampling and soil moisture sensors, and Raman spectroscopy instruments. These instrumented probes can be used to "screen" the soil and vadose zone and locate regions of interest for follow on sampling. A soil sampling probe can then be deployed to a specific targeted depth to retrieve soil samples at only those points of interest. Removal of the CP probes produces a small diameter

Benefits and Features

- ◆ Cheaper soil and vadose zone waste screening
- ◆ Multiple number of different sensors can be used with the cone penetrometer
- ◆ Cone Pen can reach depths up to 170 feet in Hanford soils

hole that can be closed using grout. Push-depths as far as 170 feet have been achieved in Hanford soils. Such depths are adequate to provide the information of plumes that are believed to be within and around the base of the tanks. Achieved depths are dependent on soil composition and the push capabilities of the CP deployment vehicle.

Demonstration Description

Applied Research Associates, Inc. (ARA) of South Royalton, Vermont, under contract to the Hanford Tanks Initiative project, demonstrated the use of a multi-sensor probe (MSP) and a multi-sample soil sampling probe (SSP) at two Hanford locations. A CP probe preparation goal and DOE project milestone were met during the last quarter of FY 1998 when the complete CP system was first operated as a system to obtain data during a trial push in the 200 East Area. The activity marked the beginning of the Hanford Site cold push activities for performance evaluation and qualification testing. The demonstration push involved the positioning of the CP at the Immobilized Low Activity Waste Disposal Complex (ILAWDC), pushing of the multisensor probe with the data acquisition system operating, and the gathering of signals from the MSP instruments during the push event. During the weeks that followed the initial developmental push, additional push events were conducted on the probes (MSP and SSP) to further evaluate performance parameters and to set the stage for final probe qualification testing. The MSP included an X-Ray fluorescence detector, a gamma detector, and a soil moisture sensor.

Demonstration Results

The MSP was successfully demonstrated as a complete system to a depth of 25 feet. The MSP gamma spectroscopy instrument provided a resolution of 7.5 percent, which is one percent lower than that required by the probe preparation specification. Testing of the gamma module indicated that the minimum detection limit for Cesium-137 is 11.5 pCi/gm in Hanford soils. The MSP probe was also used to determine the soil

stratigraphy and volumetric moisture content of the soils that were penetrated. These results were compared with other characterization information in the historical records for the test site and found to be consistent with earlier findings.

Prior to the field testing, the soil sampler (SSP) down-hole latching mechanism had been completely redesigned to provide greater reliability and a more robust lock-up. The final SSP design and the test deployment, represent a first for the CP industry.

Successful completion of the initial developmental push provided sufficient positive results to warrant continuing with the entire developmental testing program (and ultimately the qualitative testing). The push event also represented the first complete fielding event of the CP in conjunction with a specialized probe system.

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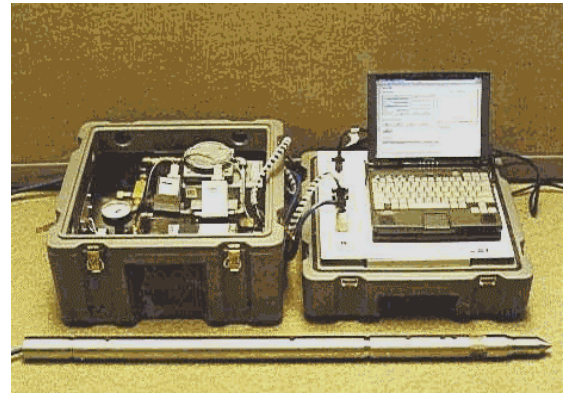
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TM-DEM-99-001



Cone Permeameter™

The Challenge

The vadose zone surrounding the underground waste storage tanks at the Department of Energy's Hanford Site contains contaminants that have entered the soil from tank leaks. Characterization of both the radiological and chemical contamination as well as the geohydrological properties is important for modeling to determine the contamination movement in the future as well as to design containment and remediation approaches. A typical geohydrological parameter needed for these calculations is the permeability of the soil. Permeability is the measure of the magnitude of fluid flow in the soil under imposed pressure gradients. A fast, reliable means of measuring permeability greatly aids the characterization process. With this information, a means of predicting contaminate movement, containment systems, and remediation techniques can be developed.



Cone Permeameter™ equipment including probe, instrumentation and pump box, and analysis computer.

Current Approach

Permeability is typically measured using laboratory analysis of soil samples removed from the formation. The soil samples are tested in the laboratory by injecting a fluid in one side of the sample and measuring how long it takes to pass through the sample. Measurements are made using both air and water as the injection fluid, although saturated measurements are the most common. One drawback of the laboratory testing technique is that great care must be taken when the samples are collected to minimize the disturbance the soil structure of the sample. The soil structure can have a great influence on the permeability measurement.

Two types of field tests are occasionally conducted to gather large-scale permeability estimates. The first is a pumping test, which is conducted over a very large scale, is expensive and therefore only used on large projects. This test may also move existing contaminate and must be used with care. Another field test that is more commonly used is a single well slug test. The test regions of a well are packed off and water injected into the formation. The time to inject a given volume of water or air is used to determine the permeability.

New Technology

The Cone Permeameter™ (CPer) system, developed by Science and Engineering Associates, Inc., is a technology which uses a cone penetrometer (CP) as a delivery system and has the capability of measuring both in-situ air permeability and saturated hydraulic conductivity of soils. The measurement system utilizes a spherical

Benefits and Features

- ◆ Fast, single-point, in situ measurements
- ◆ Real-time results available
- ◆ No drilling waste generated

flow geometry methodology. The basic premise of the approach is that as fluid is injected from a discrete point of the penetrometer rod it will result in a spherical flow pattern as the fluid moves outward from the rod. Eventually, for a given injection rate, the radial pressure profile along the axis of the penetrometer rod is identical to that which would occur if the rod did not exist. Measurement of the pressure gradient at a distance from the injection point produces the required information to calculate the permeability of the formation.

This approach to characterization allows multiple readings to be taken at specific depths during a single push. Each permeability measurement takes about ten minutes and the results are immediate with no laboratory analysis or waste disposal.

Demonstration Description

The purpose was to evaluate the CPer's ability to measure air permeability in arid sands, silts and gravels; and to determine the system's ability to replicate permeability profiles with multiple pushes in close proximity. The CPer was demonstrated using the Hanford Cone Penetrometer Platform developed and operated by Applied Research Associates, Inc. The demonstration required numerous test pushes within ten feet of a previously characterized monitoring well at the Immobilization Low-Activity Waste (ILAW) site in the 200 East Area. Permeability measurements were conducted approximately every meter from the ground surface down to the CP push refusal depth.

Demonstration Results

Four separate penetrations were completed, with the maximum depth attained at 62 feet (18.91 meters). Of the 33 permeability measurements attempted, 10 produced no pressure change between the pressure ports, indicating either

clogged ports or a permeability outside the measurement range of the sensor. The successful measurements indicated permeabilities ranging from 0.033 to 8.27 darcies ($3.28\text{E-}14$ to $8.16\text{E-}12$ m²). Pushes in close proximity to each other indicated permeability profiles agreeing within one order of magnitude (frequently much closer than that). Measurements were conducted in a zone where two core samples had been taken for laboratory analysis of saturated hydraulic conductivity. The equivalent saturated hydraulic conductivity obtained agreed with the laboratory samples to within half an order of magnitude. The CPer demonstration validates the technology for future applications and has the potential to aid in developing contamination mobility models important for supporting cleanup decisions.

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Fluor Daniel Hanford, Inc., Technology Management
TM-DEM-99-002

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Laser Ablator for Decontamination of Metal Surfaces

The Challenge

Hanford has large volumes of stored contaminated remote handled mixed low-level (MLLW) and transuranic (TRU) waste. Significant quantities of both contact handled and remote handled waste will be generated during cleanup activities over the next 35 years. The current and future waste management cost could be significantly reduced if an economical surface decontamination method can be found to reduce the volume of the remote handled waste or reduce the volume of TRU waste by reclassifying to low-level waste. The majority of contamination on waste items including tools, equipment and materials is on the surface.



Above – technician (wearing eye protection) for inspecting a Hanford “T” handle sample carrier. Left – bayonet sample carrier cap undergoing laser surface decontamination.

Current Approach

Current approaches, which include the use of chemical solvents, water jet cleaning and pellet blasting, produce significant amounts of secondary waste and/or are only effective on smooth surfaces with loose contamination.

New Technology

Laser ablation is a technology that has high potential for cleaning a variety of surfaces with loose or fixed contamination without generating significant amounts of secondary waste. Key performance requirements include ability of the system to remove fixed contamination from a variety of surfaces and shapes while controlling contamination spread and meeting applicable emissions standards (ALL of the material removed from the surface must be collected). The system must also meet the Hanford Site laser operation safety standards for eye and skin protection.

Benefits and Features

- ◆ Cleans surfaces without generating significant amount of secondary waste
- ◆ Can be controlled to pinpoint accuracy
- ◆ Can adjust for various surface types

At least one potential vendor has shown that it can meet these requirements in a demonstration using a low energy pulsed Neodymium Yttrium Aluminum Garnet (Nd:YAG) laser, a safe and reliable technology for cleaning metal surfaces. The demonstration was conducted with a 200-watt laser, operating at approximately 120 watts and about 10,000Hz. The beam was focussed on approximately 1 micron of surface area on the specimen using a fiber optics delivery system.

Demonstration Description

Three different high-level waste sample carriers were coated with contamination simulant and sent to General Lasertronics Corporation for the demonstration. The sample carriers were not radioactively contaminated and were selected to represent various shapes and sizes as may be encountered in lab operations. A video camera was used to document the demonstration.

To simulate contamination, the sample carriers were coated inside and out with a paint visible only with UV light. Green paint was also applied to some of the surfaces for visual effect under ordinary light to aid the video recording. The effectiveness of the system was qualitatively monitored by observing the removal of green paint and UV visible paint. No attempt was made to quantitatively measure the actual surface depth removed.

Demonstration Results

The demonstration results in terms of three areas of interest were as follows:

Effectiveness - The laser ablator had no difficulty cleaning surfaces of the lead and stainless steel sample carriers that can be accessed even at a large incidence angle. Difficulty was, however, encountered in getting the laser to contact the vertical surfaces of small diameter boreholes. While not demonstrated, it appeared a laser system could be designed to clean the tight spaces such as bored holes and inside corners.

Only slight adjustments in the laser focussing system were necessary to accommodate changes in material properties of lead and stainless steel. The low energy density employed cleaned lead

somewhat faster than shiny stainless steel surfaces. This might be expected if energy absorption/reflection at the surface and melting or vaporization temperature are key factors in disengaging the contaminant from the surface. *Safe Operation is Feasible* - Safe and controlled operation appeared feasible. Laser safety glasses will be required as expected. Skin protection was not required during the demonstration as shown more explicitly in the video. The system could be controlled and lends itself to automation with pin-point accuracy.

Collection of Ablated Material - Does the technology just smear the surface or spread materials around? Does it vaporize the material in such a form that it cannot be collected in HEPA filters? Answers to these questions will require more work than was covered in this demonstration.

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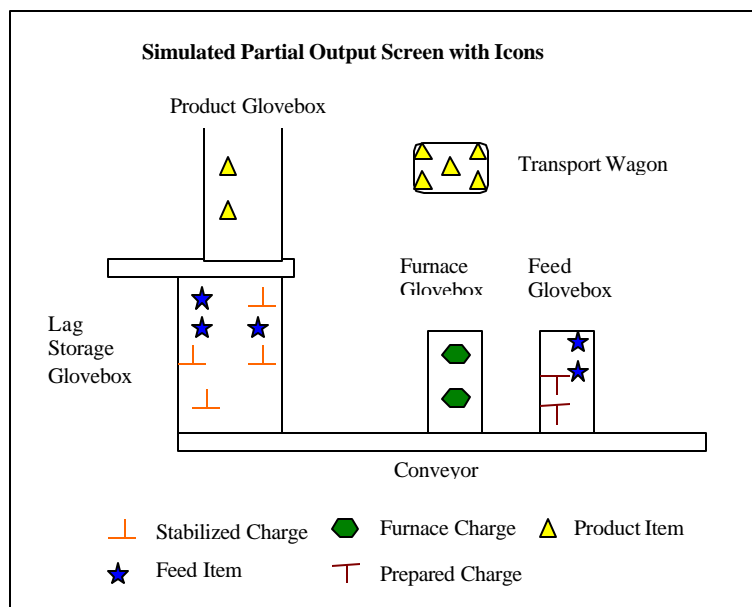
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TM-DEM-99-004



Simulation of the Stabilization Processing at the Plutonium Finishing Plant (PFP)

The Challenge

The Plutonium Finishing Plant (PFP) is one of the many facilities that were constructed at Hanford in support of the weapons complex fissile material production mission. PFP has two significant remaining missions: 1) stabilization and repackaging of plutonium-bearing materials and 2) storing Special Nuclear Material. Many processes and activities for stabilization and repackaging will be conducted including thermal stabilization of solid residues, plutonium solution conversion to solids, and cementation. These activities will be performed in several buildings and in various gloveboxes. Logistical choke points or holdups could occur due to the large number of tasks and plutonium items that will be in process at any given time. The amount of lag storage for in-process material, criticality concerns, and dose considerations for operations personnel also need to be considered to optimize the complex processing activities.



The schematic above is a simulation of a process operation model, indicating where logistical choke points and resource constraints may occur.

Current Approach

Analysis of process needs for the individual processes are performed for flowsheet development, and consideration for interfaces with other facility activities is included. However, this does not provide an overall assessment of all potential concurrent activities, nor does it optimize for more than one process.

The strategic planning for stabilization activities at the facility, documented in the Integrated Project Management Plan, reflects apportionment of resources and budget to schedule major process campaigns, but does not provide for optimization of dose, lag storage, or address potential process logistical concerns.

Benefits and Features

- ◆ Identifies and solves logistical problems
- ◆ Finds best opportunities for dose reduction
- ◆ Optimizes lag storage capacity
- ◆ Illustrates personnel needs to optimize processing
- ◆ Allows “what if” investigations

New Technology

Arena® software is designed to model complex process operations, both in time and space, to enable projections of logistical choke points and resource constraints. The software also allows tracking of parameters associated with any given task, such as dose to operators or amount of waste produced. The level of detail in the model is complex, allowing nearly every action that is taken in the real operations to be included. Results for many process parameters can be obtained on reports, including personnel hours needed for any given operation, doses, wait times, and throughput rates. Input assumptions and parameters can be varied to assess the impact on the results, and the process sequence can be changed to seek improvements in dose reduction or throughput rates.

Demonstration Description

The Arena® was used to model PFP stabilization processes: thermal stabilization of residues, metal stabilization, solutions conversion to solids, and vault transfers for plutonium items at the PFP. Operations and engineering personnel at the PFP were involved in the model development, assuring that critical components such as waste operations, key steps in sealing material out, and transfer operations were properly included. Storage locations, gloveboxes, and process equipment were each illustrated by icons. The model was run on a time-step basis.

Demonstration Results

The model produced a simulation that appears to give production rate results very similar to those

actually seen in operation of the thermal stabilization process.

The results were viewed on a step-wise computer projection of the process gloveboxes and buildings. The icons moved from vault storage to lag storage, then to feed preparation gloveboxes, to process equipment, back to lag storage, and eventually back to vault storage.

Further application of the Arena software is in the FY 2000 baseline planning to provide integrated modeling of several different PFP processes.

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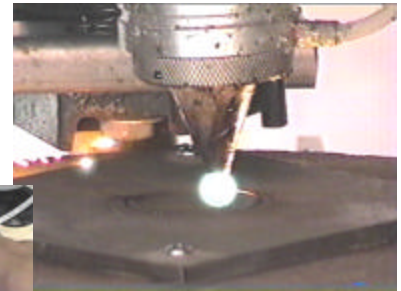
Arena® is a registered trademark of Systems Modeling Corporation.



Laser Cutting of Cell Liners

The Challenge

The 324 Building, located at the Hanford Site is being deactivated to meet state and federal clean up commitments. The 324 Building B-Cell is a large hot cell that was used for high-radiation, high-contamination chemical process development and demonstrations. This hot cell was constructed with concrete walls and a stainless steel liner. The cell is contaminated with high dose radionuclides from the previous activities. Contamination may also have worked into the gap between the cell liner and the concrete walls. During the decontamination and decommissioning (D&D) of the hot cell, removal of the cell liner may be required to complete B-Cell cleanup activities.



Above: Nd:YAG laser cutting 1/4-inch stainless steel plate with concrete backing. Left: Resulting circular cut.

Current Approach

The current approach for B-Cell clean up is to deploy a remote/robotic work platform possessing full access capability within B-Cell. The Platform will be the deployment mechanism for commercially available off-the-shelf tools and future end effectors. The tools or methods to perform liner removal have not been identified. Currently used size reduction tooling and techniques (such as saws, characterization tools, high-pressure water jets, and plasma arc cutting) are being considered for sectioning and removal of the liner.

New Technology

A high powered Neodymium Yttrium Aluminum Garnet (Nd:YAG) laser technology is being developed under the auspices of EM-50's Accelerated Site Technology Deployment (ASTD) program for cutting apart contaminated gloveboxes and equipment. This type of laser equipment was recognized as having potential for application to cutting a cell liner.

Demonstration Description

A Nd:YAG laser unit has been loaned to the Los Alamos National Laboratory and is being used to cut Department of Defense munitions into sections for disposal. In the interest of the D&D work scope in the Hanford 324 B-Cell, this equipment was also used to

Benefits and Features

- ◆ Thinner and more accurate cuts, and less spatter than plasma arc cutting
- ◆ Less debris and particulates than saw cutting
- ◆ Controlled, minimal heat generation
- ◆ Synergy with Accelerated Site Technology Deployment (ASTD) program laser and robotic platform demonstrations
- ◆ Laser can also cut equipment for size reduction

execute a demonstration cut on a ¼" thick stainless steel plate (representing a typical cell liner) against a concrete block. The block was rotated to create a circular cutout. There was some concern that the concrete backing would cause excessive spatter or create focussing problems, therefore the demonstration was visually monitored and videotaped to observe results.

Demonstration Results

The demonstration cut proceeded smoothly, showing that a clean cut through the full thickness of the steel plate could be made. The concrete backing was only slightly ablated. While some sparking was observed, it was minimal. Essentially no spattering of the stainless steel was observed. The cut was stopped approximately halfway through the circle, then successfully restarted. Cutting rate was 3 cm/min, and applied power was 1 kW.

These results provide confidence that technology for cell liner removal based on laser cutting is available and effective. An end effector for the robotic platform arms using a laser cutting head could cut relatively precise portions of the cell

liner, with a separate robotic arm removing and packaging the pieces. In addition, the laser cutting tool could be used for a variety of cutting and size reduction applications for other equipment and piping located in hot cells and other facilities.

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Plutonium Finishing Plant (PFP) Glove Port Monitor

The Challenge

At the Hanford Site's Plutonium Finishing Plant (PFP), Special Nuclear Materials (SNM) are placed in various containers during processing, storage, and for waste disposal. The amount of SNM in each item must be known for safety during handling and storage, and for safeguards accountability. As SNM items are moved between storage and gloveboxes during stabilization activities, accurate accounting becomes more difficult. Also, in-process materials in gloveboxes must be periodically checked to determine the amount of SNM present for inventory control purposes. Handling and waste management costs could be reduced if improved methods for the plutonium measurement process are developed.

Current Approach

In order to measure the SNM content in an item which is inside a glovebox, the item is transferred out of the glovebox using a method called a seal-out. Operators and radiological control technicians don Personal Protection Equipment (anti contamination clothing and respirators), place the affected airspace on Airborne Radioactivity Status, and then use a plastic bag and heat sealer to move the item out of the glovebox and separate the plastic containment. This process is designed for worker protection and safety. It is a costly and labor-intensive practice. Other operational activities in the same facility airspace are impacted during the seal-out process due to the increased potential for personnel radiation exposure.

The items are moved to Nondestructive Assay (NDA) counters to ascertain the amount of SNM they contain, then transferred back to the glovebox via a sphincter port or a seal-in, or to waste disposal, or to vault storage locations.

There is also a specific group of stored items with either unusual container sizes or high matrix densities which the existing in-plant stationary NDA equipment is not well-suited to measure properly. These items would require dose intensive repackaging for measurement on existing NDA equipment. Alternatively, the cost, dose, and risk to destructively analyze these items would be very high and also require sample seal-outs. Another measurement method has been sought to improve the safeguards accountability and handling safety posture for these items.



Gloveport Monitor system components including the germanium gamma detector (foreground), neutron counter (right), counting electronics and laptop on the table (center back).

Benefits and Features

- ◆ Minimizes TRU waste generation
- ◆ Addresses safeguards issues
- ◆ Supports As-Low-As-Reasonably-Achievable (ALARA) by minimizing radiation exposure to personnel
- ◆ Avoids risks of contamination spread inherent in seal out
- ◆ Airborne Respiratory Area setup, PPE donning, and downposting are not needed
- ◆ Convenient, portable device

New Technology

The Glove Port monitor is an easily used, transportable NDA system. Two counting detectors and the associated electronics for each are included in the system - a neutron measurement system, and a gamma-ray isotopic system. The ability to readily move this equipment will allow operators to set up the monitors next to a glove port with a seal-out bag attached. The operators will move the item into the seal-out bag, and then obtain a quantitative measurement of the SNM in the container.

The Glove Port monitor equipment may also be used to measure various containers in the field, due to the transportability of the system and the fact that it can handle a variety of container shapes and sizes up to 8" diameter and 12" tall.

Demonstration Description

The Glove Port Monitor technique, employing gamma-ray spectroscopy and neutron multiplicity and coincidence methods, was tested in May 1999, during plutonium inventory measurement verifications at PFP. Individual SNM items, similar to those produced during the reprocessing activities, were measured to demonstrate and define the system capability.

Demonstration Results

The initial demonstration showed the gamma counting portion of the system worked very well.

The neutron detector also functioned properly. Electronics and software associated with the neutron detector did not provide expected accuracy during counting, and an off-the-shelf electronics and software package that complements the detector system is proposed for purchase. Since essentially the same neutron measurement system is in use at other DOE sites, this portion of the package is expected to function properly when received.

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In Situ Vitrification



SUMMARY

The Geosafe planar in situ vitrification (ISV) process is one of the technologies being considered for treatment of drummed uranium/oil waste uncovered at the 618-4 Burial Ground in fiscal year (FY) 1998. The ISV process uses electricity to melt a selected area of soil/waste to produce a glass form that is very durable and is also an acceptable waste form for disposal in the Environmental Restoration Disposal Facility (ERDF).

The demonstration, performed by the Geosafe Corporation, used the ISV process to melt a 3.8-L (1-gal) can containing a representative sample of the drummed uranium/oil waste – depleted uranium chips and oil contaminated with various heavy metals, volatile organic compounds, and polychlorinated biphenyls (PCBs).

INNOVATIVE TECHNOLOGY DESCRIPTION

The full-scale concept using ISV to treat the drummed uranium/oil waste is to treat the drums surrounded by soil in a lined cell excavated within the burial ground. The drums would be individually breached within the cell, allowing the oil to seep into the surrounding soil and permit the escape of vapors to the soil during processing. The breached drums containing depleted uranium chips would then be covered with soil and further compacted to minimize internal void space. Each cell would be designed to treat more than 400 drums. The melting process would destroy or immobilize hazardous constituents into a vitrified monolith that could be broken into pieces and transported to the ERDF for disposal. During treatment, an off-gas collection and treatment system would be placed over the treatment cell.

BASELINE DESCRIPTION

There is no baseline technology. The presence of multiple phases, pyrophoric material, radioactivity, and hazardous constituents in the waste presented complex and potentially costly disposal issues that were not addressed through any established Hanford Site processes. Based on waste characterization results, an evaluation of applicable regulatory issues was performed and potential treatment/disposal technologies were investigated. Discussions were also held with representatives from other sites within the U.S. Department of Energy (DOE) complex facing similar waste management issues. The ISV process was selected as one potential option for treatment of this complex waste.

DEMONSTRATION DESCRIPTION

The treatability test was performed in a sand-filled barrel that was sealed inside a containment vessel. Gasses produced by heating the waste were treated on site. Funds to support Bechtel Hanford, Inc. project costs for this test were provided through the Mixed Waste Focus Area, part of DOE's Office of Science and Technology. Geosafe performed the treatability test at its own expense. The active (thermal treatment) part of the test was performed during a 12-hour period on August 30, 1999. The block of glass that was produced in the test was allowed to cool and removed from the test apparatus the following week. The glass block weighed more than 136 kg (300 lb). It was broken into pieces to observe the quality of the glass and obtain samples for laboratory analysis. Results from the laboratory analysis show that the hazardous constituents were successfully treated such that the glassified waste form is suitable for disposal at the ERDF.

DETAILS OF BENEFITS

Information collected from the treatability test will be used by Geosafe to help optimize the design and refine cost. The ISV process is one of several technologies being considered for treating the estimated 1,500 drums of uranium/oil waste at the 618-4 Burial Ground.

The information will also be shared with interested representatives from other DOE sites where there is potential for application of this type of treatment technology. Continued investigation of other treatment technologies that may be applied to drummed waste from the 618-4 Burial Ground is planned during FY 2000. Remedial actions are scheduled to resume at the 618-4 Burial Ground in FY 2001.

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Staveley Ultrasonic Liquid-Level Detection Technology



SUMMARY

The Staveley Ultrasonic Liquid-Level Detection system (model 1200HR) uses ultrasonic/acoustic wave transmission through solids and liquids to measure the relative time of flight of the transmitted energy. A *pulse-echo* technique is used that employs a single sensor to determine liquid level. As such, liquid-level information in tanks or equipment can be obtained for use in planning decommissioning activities.

The 221-U Facility contains numerous vessels and equipment that need to be assayed to determine whether liquid is present. The Staveley Ultrasonic Liquid Level Detection system was demonstrated to test whether it is a viable technology for use in the 221-U Facility. This demonstration was conducted in support of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the

Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

INNOVATIVE TECHNOLOGY DESCRIPTION

The Staveley 1200 HR ultrasonic detector is a hand-held microprocessor based system. The system uses an ultrasonic transducer (UT), with selectable single (pulse echo), dual or through transmission. The ability for water (i.e., liquids) to couple and support acoustic waves is the principle used to find liquid levels. A gel is used to couple the acoustic wave from the transducer into the wall of the vessel to be tested. The metal wall has similar acoustic impedance to the gel, along with low attenuation, and will conduct the wave to the other side of the wall. If the tank has water or a liquid with similar acoustic impedance, the inner wall wave will be transmitted at the interface and coupled into the liquid. The liquid will support the wave transmission across the tank diameter to the far side where some of the wave will be reflected back across the liquid. This reflected wave is coupled back into the near wall where it is detected as an “echo”.

In a scanning mode, the sensor is physically moved along an inspection axis, and the point at which the liquid level transitions to air is when the return echo decreases significantly or disappears. This location is the “water” line. The output must be interpreted to determine the liquid level. Solids, such as sludges, are very attenuative and produce the same apparent result as air; therefore, this instrument is restricted to items that contain liquids.

BASELINE DESCRIPTION

Visual inspection, boroscopic visual inspection, and dipsticks are the baseline technologies for determining the presence or absence of freestanding liquids in facility equipment. Liquid detection in pipes is accomplished by finding low points and tapping the pipe for insertion of sampling parts.

DEMONSTRATION DESCRIPTION

The Staveley Ultrasonic Liquid Level Detection System was demonstrated on three stainless steel tanks at the 336 Building in the 300 Area at the Hanford Site. Tank 1 had an apron beneath the bottom of the tank with approximately 0.5 m (1.5 ft) of water within the tank. Tank 2 had approximately 0.3 m (1 ft) of water, and Tank 3 had no water. The technology was only able to

determine whether liquid was present in Tank 2, which is similar to applications required at the 221-U Facility. However, it was noted that training is required for correct interpretation of the instrument output.

DETAILS OF BENEFITS

The Staveley Ultrasonic Liquid Level Detection System was not selected for subsequent deployment at the 221-U Facility. However, another ultrasonic liquid detection system developed by Pacific Northwest National Laboratory was selected for deployment at the 221-U Facility in fiscal year 2000.

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Non-Intrusive Liquid-Level Detection Technology



SUMMARY

Non-Intrusive Liquid-Level Detection technology uses infrared thermography to assay tanks and equipment for the presence of liquids. As such, liquid-level information in tanks or equipment can be obtained for use in planning decommissioning activities.

The 221-U Facility contains numerous vessels and equipment that need to be assayed to determine whether liquid is present. The Non-Intrusive Liquid-Level Detection System was demonstrated to test whether it is a viable technology for use in the 221-U Facility. This demonstration was conducted in support of the Canyon Disposition Initiative (CDI) Project. The CDI Project is analyzing alternatives for the final disposition of the five large chemical processing facilities (canyons) at the Hanford Site. The 221-U Facility serves as the pilot facility for the CDI Project.

INNOVATIVE TECHNOLOGY DESCRIPTION

Non-intrusive liquid-level detection technology is the use of infrared thermography coupled with either normal ambient temperature changes or local, low-level heating or cooling to passively and non-intrusively detect liquids in tanks and piping. Specifically, infrared imaging cameras are used along with specialized testing procedures to exploit physical property variations in the tanks/pipes and contained liquid and air to produce temperature contours of images that identify the liquid levels. Infrared thermography is the process of converting heat emitted from an object into a visible, dynamic, television-like picture.

The technology provides a non-intrusive method that can be used to determine the presence or absence of liquids in congested facility equipment.

BASELINE DESCRIPTION

Visual inspection, boroscopic visual inspection, and dipsticks are the baseline technologies for determining the presence or absence of freestanding liquids in facility equipment. Liquid detection in pipes is accomplished by finding low points and tapping the pipe for insertion of sampling parts.

DEMONSTRATION DESCRIPTION

The Non-Intrusive Liquid-Level Detection System was demonstrated on three stainless steel tanks at the 336 Building in the 300 Area at the Hanford Site. Tank 1 had an apron beneath the bottom of

the tank with approximately 0.5 m (1.5 ft) of water within the tank. Tank 2 had approximately 0.3 m (1 ft) of water, and Tank 3 had no water. The technology was able to determine whether liquid was present in each of the tanks. However, it was noted that training is required for correct interpretation of the instrument output.

DETAILS OF BENEFITS

The Non-Intrusive Liquid-Level Detection System successfully detected liquids within the

test vessels and was selected for subsequent deployment at the 221-U Facility in fiscal year 1999.

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Sonic Cone Penetrometer



SUMMARY

The sonic cone penetrometer is a technology enhancement to a standard cone penetrometer. The enhancement allows the application of vibratory energy to aid in advancing the cone penetrometer rods.

The demonstration was performed to assess the ability of the sonic vibratory energy to enhance penetration depth in several types of geologic formations at the Hanford Site.

INNOVATIVE TECHNOLOGY DESCRIPTION

The sonic cone penetrometer uses high-frequency vibrations induced by a special attachment on the hydraulic head of a cone penetrometer. This technology is an adaptation of a standard cone

penetrometer technology.

BASELINE DESCRIPTION

The baseline technology is the cone penetrometer.

DEMONSTRATION DESCRIPTION

The demonstration was conducted at three sites on the Hanford Site. Initial pushes were made in the 100-D Area near the “chrome hot spot.” The second and third sites were located in the 200 East Area at the head end of the 216-B-2-2 Ditch and the 200 West Area just south of the SX Tank Farm, respectively. The objectives of the demonstration were as follows:

1. Determine if the sonic cone penetrometer can achieve greater depths of penetration than a high-push-capacity cone penetrometer rig using static penetration techniques in Hanford Site soil conditions.
2. Evaluate the ability to penetrate difficult formations using the core barrel and/or samplers.

The depth of penetration varied significantly from push to push, with a maximum depth of 40.8 m (134 ft) at the 200 East Area location and a minimum depth of 1.8 m (6 ft) at the 100-D Area location. Compared to a standard cone penetrometer, the sonic cone penetrometer routinely achieved greater depth of penetration in soils in the 100-D Area but did not measurably aid in increasing the depth of penetration in the 200 Areas.

The core barrel cutting tool was used at two sites to collect soil samples. A sample was collected from the 200 West Area in fine-grained sediment at the 19.8-m (65-ft) depth. Sample recovery was 0% in the 100-D Area.

DETAILS OF BENEFITS

Use of a sonic vibration head for the cone penetrometer technology appears to aid in obtaining greater depths in some geologic

formations, particularly those with larger grain sizes. However, penetration was not impacted in others. Full operation of all instrumentation and sensors associated with cone penetrometer application under sonic conditions was not demonstrated.

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